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# Dollars and Sense of Depreciation

*By Louis R. Howson*

DEPRECIATION and retirement of physical property, like death in humans, is inevitable, and, like human experience, mortality of utility equipment is influenced by the characteristics of each individual property, its physical constitution, environment and the hazards inherent in the service which it performs. Also, utility properties, like the human race, do not expire in toto. They, too, are continuing enterprises even though, like individual human beings, their plant items are subject to finite life. With improvement in the art, utility property items, like humans, have an increasing life expectancy and where new additions are constantly being made and old-age items being retired, the over-all composite ages of both utilities and the human race are growing but slightly and certainly not in parallel with the passage of time. With both humans and utilities it is practicable to set up annuities (or annual depreciation allowances), but in neither case does the accumulation in the reserve fund precisely represent the accrued depreciation of an individual person or property.

Although the existence of depreciation is universally admitted, the extent to which it is present and the most practicable means of measuring and financing it are highly controversial.

Recently, renewed attention has been directed to the question of depreciation as a result of a report prepared by the Committee on Depreciation of the National Association of Railroad and Utilities Commissioners. The recommendations and implications of this report are of such vast import to all utilities and especially to the long-lived water utilities as to warrant the most serious consideration.

The Board of Directors of the American Water Works Association, at its January 1944 meeting, approved the appointment by President Morris of a special Depreciation Committee to study the NARUC report with special reference to its application to the water utilities. The committee completed its report late in April. It was approved by the A.W.W.A. Executive Commit-

A paper presented on June 14, 1944, at the Milwaukee Conference by Louis R. Howson, Cons. Engr., Alvord, Burdick & Howson, Engrs., Chicago.

tee and filed with the NARUC Committee before April 30, the final date set by that committee for the receipt of discussions of its report. (The committee's report was published in the June 1944 Journal of the A.W.W.A.)

The NARUC report covers some 275 printed pages. With much of it there is rather universal agreement. However, it contains some recommendations at wide divergence with past procedure, only the most important of which will be discussed.

## Highlights of NARUC Report

The major items to which your attention will be directed in this discussion are:

1. A fundamental divergence in the definition of depreciation as stated in the NARUC Committee report from present legal and generally accepted procedure, even that of NARUC's own Uniform Classification of Accounts.

2. The recommendation that the "straight-line" method be used both for setting up annual depreciation allowances and for determining accrued depreciation.

3. The statement that the reserve computed on the straight-line basis *is the actual* depreciation in the property.

4. The recommendation that the depreciation reserve be increased to that computed on the straight-line basis by charge to surplus or otherwise.

## Definitions

The principle of depreciation has nowhere been better stated than by the U.S. Supreme Court in the Knoxville Water Co. case (*Knoxville* v. *Knoxville Water Co.,* 212 U.S. 1) in 1909:

> A water plant, with all its additions, begins to depreciate in value from the moment of its use. Before coming to the question of profit at all, the company is entitled to earn a sufficient sum annually to provide not only current repairs, but for making good the depreciation and replacing the parts of the property when they come to the end of their life. The company is not bound to see its property gradually waste, without making provisions out of earnings for its replacement. It is entitled to see that, from earnings, the value of the property invested is kept unimpaired, so that, at the end of any given term of years, the original investment remains as it was at the beginning. It is not only the right of the company to make such a provision, but it is its duty to its bond and stockholders, and, in the case of a public service corporation, at least, its plain duty to the public.

Following that decision it has been almost the universal practice of utilities to set aside from revenue each year an amount sufficient to cover the item of depreciation during that year.

There are various concepts of depreciation. Possibly the best legal definition is that of Mr. Chief Justice Hughes in the Lindheimer case (292 U.S. 151), as follows:

> Broadly speaking, depreciation is the loss, not restored by current maintenance, which is due to all the factors causing the ultimate retirement of the property. These factors embrace wear and tear, decay, inadequacy and obsolescence. Annual depreciation is the loss that takes place in a year.

The NARUC Uniform System of Accounts states:

> "Depreciation," as applied to depreciable utility plant, means loss in service value not restored by current maintenance incurred in connection with the consumption or prospective retirement of utility plant in the course of service, from causes which are known to be in current operation and against which the utility is not protected by insurance. Among the causes to be given consideration are wear and tear, decay, action of the elements, inadequacy, obsolescence, changes in the art, changes in demand and requirements of public authorities.

The present report of the NARUC Committee on Depreciation diverges materially from these definitions which

to date are the law of the land. The definition in this new volume reads:

2. The significance of the depreciation phenomenon may be described as follows:

(a) Depreciation is the expiration or consumption, in whole or in part, of the service life, capacity, or utility of property resulting from the action of one or more of the forces operating to bring about the retirement of such property from service;

(b) The forces so operating include wear and tear, decay, action of the elements, inadequacy, obsolescence, and public requirements;

(c) Depreciation results in a cost of service.

Careful comparison of the legal definitions and that of the NARUC Depreciation Committee shows that, whereas the earlier definitions refer to loss in *value* not restored by current maintenance, that is now superseded by "consumption in whole or in part of the service *life*, capacity or utility of property." Depreciation under this new definition becomes a question of consumption of *life* rather than of *value*. Depreciation as developed in the NARUC Committee report is, in fact, amortization of original cost on a straight-line basis and bears no relation to the actual facts of depreciation. The *Encyclopedia Britannica* defines depreciation as "inevitable wastage in the value of assets" and amortization as "liquidation or extinguishment of an asset by means of a series of partial payments prorated to extend over the period during which the asset will exist." Depreciation and amortization are not synonymous. It is depreciation with which water works properties are concerned.

## Depreciation Accounting

Depreciation occurs and must be financed irrespective of whether the water works are municipally or privately owned, although the factors affecting depreciation accounting methods and policies are frequently influenced to some extent by the ownership.

In only a few states are publicly-owned utilities subject to regulation. Their depreciation methods and policies are therefore largely determined locally. Publicly-owned water utilities in general set up larger depreciation reserves than the private companies and ordinarily use the straight-line method for annual allowances. The reserve thus accrued frequently bears no direct relation to the actual accrued depreciation of the property. This policy of liberal reserves provides funds required for plant additions and obviates delays and costs incident to bond issues otherwise necessary.

Most privately-owned utilities are operated under governmental regulation and the annual depreciation allowance is either fixed or approved by the regulatory body. Their accrued depreciation and present value are usually checked at more or less frequent intervals in studying the fairness of rates for service. As a result of several decades of regulation the privately-owned utilities usually maintain a closer balance between annual and accrued depreciation and the actual requirements for each property.

Inquiry from a large number of municipally-owned water works by N. T. Veatch has disclosed that on an average of 107 cities, the amount set aside annually for depreciation was equal to 1.77 per cent of book cost and the accumulation in the reserve averaged 27 per cent of the book cost. Recent analysis of the figures from 181 privately-owned water works, shows that the average annual rate of depreciation is 0.99 of 1 per cent of the book cost and the credit balance in the depreciation reserves averages 13.4 per

cent of the book cost. The average amount of the surplus account of the 181 properties was equivalent to 6.25 per cent of the book cost.

It may appear that the NARUC Committee report and this discussion apply only to privately-owned utilities, but such is not the case. As state regulation of publicly-owned water works becomes more universal, the impact of the NARUC depreciation policy on the publicly-owned plants will become apparent. Rates fixed upon a rate base resulting from the deduction for depreciation in amount in excess of that actually existing will handicap the municipal utilities in financing future expansion. This will be particularly true where bond issues are required.

If the NARUC committee method of depreciating a property is followed, a newly acquired municipal plant, financed by revenue bonds of 40 yr. maturity will equal annual payments for interest and principal, will depreciate at a rate faster than the bonds are retired, for the first 10 yr. after acquisition, thus impairing the equity behind the bonds.

## Annual vs. Accrued Depreciation

It would seem to be self-evident that annual depreciation allowances and accrued depreciation should be reasonably in harmony. The only purpose of annual depreciation allowances is to provide for accrued depreciation as and when it occurs. The NARUC Committee report states that straight-line depreciation should be used for both annual and accrued depreciation determinations. As to these views, the report of the A.W.W.A. Depreciation Committee states:

> Our group has no disagreement with the general principle that accrued depreciation and annual allowances must be reasonably in step. We do disagree completely with the applicability of the straight-line theory in the determination of accrued depreciation of long-lived water works structures. We hold that the accrued depreciation reserve must be closely related with the facts of depreciation and most water works property does not depreciate in a straight line.

Accrued depreciation is a fact. It is either there or it is not; and if it exists the extent to which it exists is also a factual matter. Annual depreciation is simply a means of financing that fact in the amount and at the time it occurs. No method of financing can add to or detract from the amount of actual depreciation which a property has suffered. In the report of the NARUC Committee it is stated that if the sinking-fund method of computing depreciation expense is used no accrued depreciation should be deducted in fixing the rate base. The fact that the annual allowance has been set aside by the sinking-fund method cannot in any way affect either the actuality or the amount of depreciation which has accrued on the property. It can only affect the accounting. Similarly, the assertion which the report reiterates so frequently—the actual depreciation is determined by the amount of the depreciation reserve computed on the straight-line basis—is equally unsound. That, too, is only an accounting procedure. The charge entered on the books cannot possibly affect the physical condition of the property. Under the NARUC Committee's theory two identical properties, one of which sets up depreciation on a sinking-fund and the other on a straight-line basis, would have different values. The actual depreciation is independent of the method by which it is financed.

The NARUC Committee report states that the straight-line method should be adopted because it is simple

and less affected by errors than other methods. Is that true as applied to the long-lived water utility? Actually, straight-line depreciation is based wholly on estimates. First, it involves an estimate of the life expectancy of each property unit. Of course that estimate is easily made for short-lived units like electric light bulbs, telephone instruments, railroad ties or electric power line poles which have already passed through several life cycles. But what is the life of cast-iron pipe, which makes up about two-thirds of the value of the average water works? Is it 65 yr. (as stated in Bulletin F of the U.S. Treasury Dept. Bureau of Internal Revenue) for 6-in. pipe (50 per cent of the average system) or is it 100 yr. as some commissions and engineers have assumed? Or is it 200 yr or 500 yr.? In the first 15 water plants studied by the A.W.W.A. Committee on Survival and Retirement Experience With Water Works Facilities there had been installed 34,654,567 lin.ft. of 6-in. and larger cast-iron pipe in periods beginning with 1821. Only 1,464,624 ft. or 4 per cent had been removed for all causes and the average survival ratio was 93.1 per cent, with the average experience record of 66.3 yr. Very few cities have removed as much as 5 per cent of the cast-iron pipe laid. Its life will apparently vary widely as between different systems. Many systems serving 50,000 or more people have practically no retirement experience on which to hazard even a decent guess as to the average life expectancy of its pipe system.

This point is illustrated by the testimony of an old "river rat" in an important flood lawsuit. He was semi-illiterate, 88 yr. of age, was born and had spent his entire life on a houseboat making a precarious living by salvaging floating timbers from the Missouri River during high-water periods. After testifying freely with a remarkable memory of the flood history of the Missouri during his lifetime on its banks, he was asked whether he remembered the 1881 flood. Upon his affirmative answer the attorney asked him if that wasn't the greatest flood there ever was on the Missouri. The old man replied he did not know and stuck to it. When finally asked why he didn't know in view of his 88 yr. spent on the river's banks he replied, "Because I'm not old enough." I wish that some of the depreciation experts were as frank.

After estimating the life of an item such as cast-iron pipe with such accuracy (?), the next step in this simple process is to estimate the net salvage at that far distant future mortality date so that amount can be deducted from original cost to get the depreciation base. What will scrap pipe be worth say in the year 2000 or 2100?* What will it cost then to remove the pipe? What will labor rates be? What kind of paving will be over the pipe—or will the city be there at all? It is difficult enough to estimate net salvage at the present time. To project that process a century or two in the future is neither simple nor accurate.

*This type of simplicity apparently consists in drawing a straight line from an unwarranted assumption to a foregone conclusion.* "Actual loss in value not restored by current maintenance" is not influenced by whether that line is straight or curved or what bookkeeping entry may be made.

### How Should Accrued Depreciation Be Determined?

Having disposed of the NARUC Committee recommendation, what is

the alternative suggested? The A.W. W.A. Depreciation Committee expresses itself on this as follows:

> We believe the proper annual allowance for depreciation on water works structures of long life is arrived at by a careful determination first of the actual depreciation accrued to date, and from that a determination of the annual rate; both the annual rate and the accumulation in the reserve should be periodically reviewed, and the annual allowance adjusted if necessary to bring it into closer harmony with the actual depreciation requirements.
>
> The determination of the actual accrued depreciation involves a careful inspection of the property by one properly qualified through a background of design, construction and operation of similar properties, a careful study of operating and maintenance records, a study of the past and probable future needs for the service which the unit of property performs and its ability to meet them, the history of this unit or property and others of its type under comparable conditions, the presence or apparent imminence of obsolescence and other factors that affect the future usefulness in the particular property being studied.

The NARUC report calls that an estimate. Of course it is. But the author believes an experienced builder can estimate the condition of this building more accurately than an accountant can forecast how many years it will be here, and certainly the former will more nearly reflect its actual depreciation, which is what we want to know. The amount of accrued depreciation having been determined, the annual allowance should be such that, if accumulated over the years in which the property has been in service, it would have provided the amount so determined in a reserve. This study should be repeated as frequently as necessary, usually at intervals of from 5 to 10 yr. When done in this practical manner, the reserve will always be reasonably in step with the annual allowance and the amount in the reserve will reasonably approximate the actual depreciation of the property.

The reserve will usually be somewhat larger than the actual depreciation in the property, for the reason that the annual allowances must reflect the depreciation which results from contingencies and casualties but which is not deductible as actual depreciation until it matures or can be reasonably foreseen. The NARUC report says that the accrued depreciation on a straight-line basis with the assumed life reflecting all casualties whether or not they have occurred *is the actual depreciation.* This divergence of views is illustrated by the automobile. The fact that the average automobile may sustain a $250 collision damage once in 5 yr. cannot possibly detract from the value of a car not yet smashed up. The NARUC Committee method, however, would reduce each car's value $50 per year on that account. The annual allowance for depreciation must, of course, recognize the possibility that the casualty will occur, but it certainly is not deductible as accrued depreciation until it actually has occured. Similarly, contingencies are not actual depreciation until they mature or can be reasonably foreseen. For example, the annual depreciation allowance in the Cincinnati Water Works should have reflected some provision for the contingency of a flood as high as that of 1937, even though such a flood had not occurred since the inception of the water works more than 100 yr. earlier. However, the accrued depreciation of the Cincinnati Water Works could not and did not reflect that contingency until the unprecedented flood occurred. Under the NARUC Committee report theory 50 per cent of the depreciation which matured with the 1937 Cincin-

nati flood was actual and deductible from the plant value 50 yr. before the damage occurred. Preparation must be made in advance for floods, casualties and obsolescence, but that preparation does not mean that there has been any deterioration in the property prior to their occurrence. To hold otherwise seems an incongruous mixture of fact and theory.

## Fact and Theory

All through the NARUC Committee report there appears to be a confusion between fact and theory. The statement that the accumulations in a depreciation reserve by a straight-line method are "actual depreciation," is believed to be inaccurate, misleading and unfortunate. *The proper theory should be made to agree with the facts —not the facts warped to agree with a theory which is in conflict with universally recorded experience.*

Depreciation of long-lived structures and equipment that make up the ordinary water works does not increase on a straight line from the time of installation until the time of removal. The accumulations in a reserve on a straight-line basis for water works property accordingly do not accurately measure the accrued depreciation. They are usually greatly in excess of the demonstrated requirements or the actual depreciation which the reserve is to finance.

Let us apply this NARUC depreciation principle to some of the important water works equipment. In the average water works which has been completely metered for some time, the average age of the water meters is 20 yr., more or less. From a practice before many of the state regulatory commissions, the author knows of none using an age-life basis which has given a life to meters of more than about 40 yr., and 30 yr. is frequently used. On the NARUC Committee report basis the "actual" depreciation of the average water meter in service is therefore approximately 50 to 66.66 per cent. Do any of you water works men believe that your meters are only in 33⅓ to 50 per cent condition? That situation illustrates the effect of the omission of the words "not restored by current maintenance" in the NARUC Depreciation Committee's new definition of depreciation.

The ordinary water distribution system in the Midwest has a weighted average age of between 20 to 35 yr. Where commissions use age-life methods of computing depreciation they usually give water mains not to exceed 100 yr. and mains 6 in. and smaller, are frequently given shorter lives. In view of the fact that in the average distribution system approximately 70 per cent of the mains are 6 in. and less in diameter, as practical water works men can you agree with the conclusions from the NARUC Committee report that your distribution system is depreciated from 25 to 50 per cent? Is that actual depreciation or unapplicable theory?

## Retroactive Adjustment Recommended by NARUC

In various places the NARUC report states that the accumulation in the reserve by a straight-line method is the actual depreciation. In one place the report states: "Where the cost is the gross base then the reserve should be deducted from it in arriving at the rate base, for the reserve alone measures actual depreciation."

The NARUC Depreciation Committee recommends that where the depre-

ciation reserve actually accrued by the companies is less than the amount which should theoretically be in the reserve on the straight-line basis, the reserve should be brought up to the total indicated by the straight-line method by withdrawal from surplus or otherwise. Practically all privately-owned public utilities have been under governmental regulation for periods varying from 20 to 40 yr. and their annual depreciation allowances and the credit balances in the reserves reflect the practices either ordered or approved by regulatory bodies. If the recommendation of the NARUC Depreciation Committee should be followed it would mean that the present water utility reserves amounting to 13.4 per cent of book cost would necessarily be increased to from 25 to 35 or 40 per cent in most cases. Where is this money coming from, in view of the fact that the average water works surplus is but 6 per cent of its book cost? Is there anything fair or equitable in requiring this change in accounting practice and in the valuation and rate base of the utilities? To the author it seems highly unjust and ethically improper to require such a write-down in utility values.

The courts have said that depreciation is a part of the cost of service and as such must be paid by the consumer. In effect, the NARUC Depreciation Committee says to the water utilities: "You must double or triple the amount which regulatory bodies have permitted you to set up, and this excess must be taken from your surplus or by omitting dividends, rather than by collecting it from the rate payers." In the author's opinion there is nothing ethical in that kind of "back-door confiscation."

The NARUC report further states that: "The depreciation reserve should *not* be readjusted gradually through modification of the annual depreciation rates when the difference between the book reserve and the proper reserve (straight-line) is substantial." With water works this difference is substantial (100 per cent or more of the book reserves) so that this stipulation closes the door to the only means of collecting depreciation costs from the consumers according to law. Not being permitted to collect from the rate payers for the cost of property consumed in their service the difference must be taken from capital and the property values are correspondingly impaired. "Requiring the utilities to deduct from value that which they were never permitted to collect through rates is contrary to all precedent and ethical procedure."

# Municipal Depreciation Accounting Practices

*By N. T. Veatch*

THIS paper is the outgrowth of a discussion which took place at a meeting of the Finance and Accounting Division of the American Water Works Association during the annual convention of that Association, held at Cleveland, Ohio, in June, 1943. The discussion brought out the fact that there is a wide diversity in accounting practice among municipal water utilities. Most, if not all, privately-owned water properties are under the jurisdiction of state regulatory bodies and follow accounting practices prescribed by such authorities. It appeared from the discussion that there is little uniformity among water departments in regard to the use of a standard accounting system such as that prescribed by the National Association of Railroad and Utilities Commissioners or as suggested in the Manual of Water Works Accounting, published by the Municipal Finance Officers Association and the A.W.W.A. It was also apparent that the same lack of uniformity exists in regard to the handling of annual retirement or depreciation charges, and the creation of a retirement or depreciation reserve.

Depreciation losses are of such great importance in determining cost of service, adequacy of rates, etc., that it was decided to make an attempt to ascertain, as nearly as possible, how depreciation is being handled in present-day accounting practice among municipal water utilities. A questionnaire was sent out to some 275 cities, and 145 (or slightly over 52.5 per cent) were returned with pertinent information. This is believed to be a very satisfactory response, particularly now when time is invaluable and some research may be required to answer them. The information obtained is enlightening. The following table shows the number of cities reporting, for several ranges in population:

| *Population* | *No. Reporting* |
|---|---|
| Under 25,000 | 43 |
| 25,000 to 50,000 | 35 |
| 50,000 to 100,000 | 26 |
| 100,000 to 150,000 | 11 |
| 150,000 to 200,000 | 7 |
| 200,000 to 300,000 | 7 |
| 300,000 to 400,000 | 6 |
| 400,000 to 500,000 | 2 |
| 500,000 to 750,000 | 3 |
| 750,000 to 1,000,000 | 3 |
| Over 1,000,000 | 2 |
| Total | 145 |

The geographical distribution of the 145 cities reporting is shown in the following list:

A paper presented on June 14, 1944, at the Milwaukee Conference by N. T. Veatch, Cons. Engr., Black & Veatch, Kansas City, Mo.

| State | No. Reporting | State | No. Reporting |
|---|---|---|---|
| Arizona | 1 | Nebraska | 5 |
| Arkansas | 1 | New Hampshire | 2 |
| California | 9 | New Jersey | 6 |
| Colorado | 4 | New York | 4 |
| Connecticut | 2 | North Carolina | 1 |
| Florida | 4 | North Dakota | 3 |
| Idaho | 2 | Ohio | 3 |
| Illinois | 7 | Oklahoma | 3 |
| Indiana | 2 | Oregon | 2 |
| Iowa | 7 | Pennsylvania | 2 |
| Kansas | 8 | South Carolina | 2 |
| Kentucky | 2 | South Dakota | 1 |
| Louisiana | 1 | Tennessee | 4 |
| Maine | 2 | Texas | 7 |
| Maryland | 2 | Utah | 1 |
| Massachusetts | 4 | Virginia | 3 |
| Michigan | 7 | Washington | 4 |
| Minnesota | 4 | West Virginia | 1 |
| Mississippi | 1 | Wisconsin | 10 |
| Missouri | 6 | Wyoming | 1 |
| Montana | 4 | | |

The information received is representative geographically, but to a lesser extent as to the size-range of cities, because of lack of specific reports from the smaller municipalities. The data can, however, be considered as representative of average practice in the larger cities of the country.

The questions asked in the questionnaire were:

1. Do you make an annual charge to operations for retirements (annual depreciation charge)?

2. If so, how is amount determined?

3. What is the book value of depreciable property in your system? (Total of physical property exclusive of land.)

4. What is amount set aside each year for retirement or depreciation?

5. What is the present balance in your retirement or depreciation reserve account?

6. Do you carry an actual cash reserve for retirements or depreciation, or do you carry merely a book figure, the money being used for plant extensions?

7. Do you keep books in accordance with any standard system of accounts such as that outlined in the A.W.W.A. Manual of Water Works Accounting, or that of the National Association of Railroad and Utilities Commissioners? Name?

8. Have you ever had your system appraised to determine its actual cost, and the total amount of accrued depreciation existing in the system?

Answers to question No. 1 show that out of the 145 cities reporting, 107, or 73.8 per cent, make an annual charge to operations for depreciation.

Answers to question No. 2 indicate that approximately 70, or 65 per cent of the 107 cities making such annual charges for retirement or depreciation, calculated the amount by applying an annual percentage rate to the total book figures for each of the major accounts or like groups of property. The other 37 cities used various methods, some applying a fixed percentage to the entire capital account shown in the books, while others applied it to the depreciable property portion of the total capital account only. Some of the cities use a flat figure annually, the amount varying in some cases from year to year. Others used some modification of the different methods mentioned above.

Twenty-five cities out of the total of 70 cities that apply an annual rate to major accounts, reported the annual rates used. These are summarized in Table 1.

The percentages shown in Table 1 were probably determined by several different methods, but the amounts indicate a mixture of sinking-fund and straight-line rates, the latter being more predominent. The average composite

TABLE 1

| Class of Property | Percentage Annual Allowance for Depreciation | | |
|---|---|---|---|
| | Minimum | Maximum | Average |
| Structures: | | | |
| Buildings | 1.33 | 3.0 | 1.98 |
| Dams and tunnels, etc. | 0.80 | 1.0 | 0.90 |
| Wells | 3.00 | 7.0 | 3.94 |
| Pumping equipment | 2.00 | 10.0 | 4.37 |
| Mains—cast-iron | 0.67 | 2.0 | 1.29 |
| Valves | 1.00 | 2.0 | 1.52 |
| Services | 1.50 | 6.5 | 3.21 |
| Meters | 2.00 | 10.0 | 4.21 |
| Hydrants | 1.33 | 5.0 | 1.99 |
| Furniture and fixtures | 3.00 | 10.0 | 7.61 |
| Transportation equipment | 10.00 | 25.0 | 17.60 |

annual rate, expressed as a percentage of depreciable property for 100 of the 107 cities making annual allowances for depreciation, was approximately 1.77 per cent per year. This is, generally speaking, higher than composite rates allowed by regulatory commissions in determination of rates for private companies. As the above rate of 1.77 per cent is a weighted average of all of the 97 cities, inference should not be made that all of the rates applied are too high. As a matter of fact, all data obtained from this survey should be considered as average mass data, indicating only the general and average situation, and should be applied to individual cases only on that basis.

Answers to question No. 3, in regard to book value of depreciable plant, show that the total book value of depreciable property in all of the 107 cities maintaining a depreciation reserve and making annual allowances for retirement or depreciation, is $1,047,000,000. This represents 77.8 per cent of the value of depreciable property in all of the 145 cities reporting which amounts to $1,346,000,000. The total book value of depreciable property in cities where no reserve is maintained for retirement or depreciation is $299,600,000, or 22.2 per cent of the total in the 145 cities.

## Per Capita Book Value

The population in the 107 cities which maintain retirement or depreciation reserves was, as of 1940, 13,986,182, or 76.1 per cent of the total for all 145 cities of 18,383,826. The average per capita book value of depreciable property in these cities is approximately $75. The population of the 38 cities in which no retirement or depreciation reserve is carried on the books was 4,397,644, or 23.9 per cent of the total population of all the cities reporting. The average per capita book value of depreciable property in this group of cities is approximately $68. The reasons for the difference in per capita book value of the two groups of cities is not clear but may be due to a greater cost of supply works in the larger group and to some extent to the accounting practice of both groups. The above figures indicate clearly that the data obtained in the survey are influenced by practice in the larger citites. The recognition of the need for making charges for retirement or depreciation, and creating a reserve for that purpose, would be even less general in the smaller cities, which make up the majority of the total number of water utilities in the country, than in the larger ones represented in this survey.

Answers to question No. 4, regarding the amounts set aside each year for retirement or depreciation, totaled for 97 of the 107 cities reporting such

charges, $17,747,607, or 1.77 per cent of the total book value of depreciable property in the same cities. This percentage (1.77 per cent) represents the average of all 97 cities, and many of them have individual annual allowances much higher. As a matter of fact, the composite figure of 1.77 per cent is considerably higher than the composite percentage used in a number of cities which are following schedules recommended by their state regulatory body.

Answers to question No. 5, in regard to the amount of balances in the retirement or depreciation reserve, show that the total of all balances for 100 of the 107 cities having such balances, is $254,297,972, or 27 per cent of the total book value of depreciable property in those cities. The retirement or depreciation reserve of 27 per cent indicates unnecessarily large reserves, a subject which will be discussed latter.

## Book Figure

Answers to question No. 6, regarding the character of the reserve, i.e., whether merely a book figure, the cash being used for extensions or debt retirement, or whether an actual cash reserve, show that of the 107 cities reporting, 16 cities carry the reserve as cash, 87 cities carry the reserve as a book figure and 4 cities do not state how the reserve is handled. Approximately 84.5 per cent of those cities reporting an annual retirement of depreciation allowance, carry only a book figure for the reserve, the money being used for replacements and extensions or for debt retirement.

Among the 107 cities carrying a retirement or depreciation reserve, there are three commonly used methods in which accounting for depreciation is shown on the balance sheet. These methods are:

1. The inclusion of the total capital investment in the property as an asset, the liability due to accrued depreciation being shown as a reserve for depreciation under liabilities.

2. The inclusion of the total capital investment in the property as a subtotal under assets from which is deducted the accumulated reserve for depreciation, the net remaining capital investment then appearing as a net asset in the total assets.

3. The inclusion as a net asset of the net remaining capital investment after depreciation as of the date of the balance sheet, no reference being made to the accrued amount or annual rate for depreciation.

Methods 1 and 2 give a complete and true statement of the financial position of the property so far as physical plant and the reserve are concerned. Method 3 does not show a complete record of physical plant costs and in case the accruals to the reserve (deductions from capital investment) are either too small or too large the statement of plant account is also respectively too large or too small. The plant account should be corrected annually to reflect actual additions and retirements, and not be influenced in total by the retirement or depreciation reserve. The determination of the adequacy to the reserve will be discussed later in this paper.

Answers to question No. 7, regarding system of accounts used, indicate that 90 out of the 145 cities reporting or 62 per cent, are using some standard bookkeeping system such as that prescribed by the NARUC, the Manual of Water Works Accounting or by their respective state regulatory bod-

ies. Certain others are using some modification of some of the above-mentioned systems, set up by their accountants or auditors.

**Lack of Uniformity**

It is apparent that there is a decided lack of uniformity in accounting practices in the 145 cities reporting and that it would be desirable to have all water utility properties operating at least reasonably close to some standard uniform system of accounts. Unless some uniform system of accounting is adhered to, it is impossible to make an intelligent comparison of costs and other statistical data involved in the accounting.

Since a majority of the cities that are following some standard uniform system of accounting are using that of the NARUC, for adaptations thereof by state regulatory bodies, it would seem that this would be a good system for cities to adopt if a change is made. The use of an expert accountant versed in utility accounting is always desirable, particularly in setting up a system of accounts.

Answers to question No. 8 show that 52 of the 145 cities reporting, or approximately 36 per cent, have had appraisals made of their property. The greater part of these had been made at the time of acquisition. Very few appraisals or determinations of the actual accrued depreciation existing in the respective systems had been made in the last 10 yr.

The information obtained from the survey covered in the preceding paragraphs is summarized in Table 2.

Before analyzing the facts disclosed from the survey in regard to the adequacy of annual allowances and reserves for retirement or depreciation, it would be well to review the definition of depreciation and the reasons for accounting for it.

Depreciation has been defined as "the loss in service value not restored by current maintenance." Among the general causes to be given consideration are wear and tear, decay, action of the elements, inadequacy, obsolescence, changes in the art, changes in the demand and requirements of public authorities. The combined effect of such causes is called depreciation.

The general causes of depreciation have been logically classified into two general groups by Marston and Agg.* This classification as given by the above authority is:

(1) Physical Causes
- (a) Sudden physical damage, due to
  1. Miscellaneous accidents
  2. Disasters
- (b) Physical decrepitude, due to
  1. Physical deterioration, due to action of the elements, etc.
  2. Wear and tear

(2) Functional Causes
- (a) Functional inefficiency, due to
  1. Inadequacy
  2. Obsoleteness
  3. Supersession

The division of causes of retirement into physical and functional is a natural one, as the service life of any unit of property may be, and usually is, determined by one independently of the other.

Depreciation is generally recognized as an increment of cost in all commercial business where physical property is involved. In the utility field, physical property constitutes a major part of the investment required to pro-

* MARSTON, ANSON & AGG, THOMAS R. *Engineering Valuation.* McGraw-Hill Book Co., Inc. New York and London (1936).

TABLE 2

*Summary of Data Obtained From Survey*

| | | *Percentage of Total* |
|---|---|---|
| (1) Cities making annual charge for retirement or depreciation and having a reserve | 107 | 73.8 |
| (2) Cities not making annual charge for retirement or depreciation and not having a reserve | 38 | 26.2 |
| Total number of cities reporting | 145 | 100.0 |
| Total number of states represented | 41 | 85.4 |
| Total book value depreciable property in (1) above (107 cities) | $1,047,000,000 | 77.8 |
| Total book value depreciable property in (2) above (38 cities) | $ 299,600,000 | 22.2 |
| Total book value depreciable property in all cities reporting (145 cities) | $1,346,600,000 | 100.0 |
| Population (1940) of cities in (1) above | 13,986,182 | 76.1 |
| Population (1940) of cities in (2) above | 4,397,644 | 23.9 |
| Total population (1940) of all cities reporting (145 cities) | 18,383,826 | 100.0 |
| Total amount of retirement or depreciation reserve in (1) above (includes 100 out of 107 cities) | $ 254,297,972 | |
| Ratio of reserve to depreciable property in (1) above (includes 100 out of 107 cities), *percentage* | 27 | |
| Total amount of annual allowance for retirement or depreciation in (1) above (includes 97 out of 107 cities) | $ 17,747,607 | |
| Ratio of total annual allowance to total depreciable property in (1) above (includes 97 out of 107 cities), *percentage* | 1.77 | |
| Percentage of (1) (107 cities) basing annual retirement or depreciation allowance upon percentages applied to major accounts or like groups of property | 65 | |
| Percentage of (1) (107 cities) carrying retirement or depreciation reserve as book figure only | 84.5 | |
| Percentage of (1) above (107 cities) carrying cash retirement or depreciation reserve | 15.5 | |
| Percentage of (1) above (107 cities) using some standard system of uniform accounting | 62.0 | |
| Percentage of total cities reporting (145 cities) having had systems appraised | 36.0 | |

duce and distribute the commodity sold or the service rendered, therefore, it is especially important that the matter of depreciation be considered in the accounting connected with such enterprises. The cost of service in any utility includes, among other thing, materials used up in service. These materials include not only fuel, such as coal, oil or gas, but also physical property such as pumping stations, distribution mains, etc., the cost of which includes an increment of labor required to place them in service. In the case of the fuels mentioned, it is easy to get the actual cost of the material used up in service, and very properly such costs are included in routine operating expenses. The value of physical property such as that involved in pumping stations, pumping equipment, distribution mains, etc., is used up in service just as the fuels mentioned, although their consumption takes place over much longer periods, individual items having different lengths of service lives. Nevertheless, the portion of the service value of such items used up in service each year should be charged to operating expenses, and made an in-

crement of the cost of the commodity furnished, which is water in the example under consideration. This can only be done by accounting for depreciation. The setting up on the balance sheet of a reserve for the accrued depreciation existing in the property is in accord with the method of double-entry bookkeeping on the accrual basis which gives a complete and true picture of the financial position of the utility.

That depreciation takes place is a matter of common knowledge. It seems also as apparent that it should be considered as part of the cost of service, and that such increment of the total cost should be reflected in rates charged for the commodity sold. It has been and now is so considered by courts and commissions in the regulation of rates, and it is surprising that such a large number of cities do not consider the item of depreciation as an element of operating costs.

## Plan for Depreciation

It is frequently stated that a city that is retiring its indebtedness does not need to take account of depreciation. There is enough apparent justification for such a statement to make it seem reasonable, although the premise is illogical. Assuming the money used for debt retirements comes from revenue, and that the annual amount of such retirements equals or exceeds the annual amount of depreciation accruing, it is true that the customers are contributing through rates paid for service, an amount equivalent to a charge for depreciation. Therefore, from the standpoint of adequacy of rates, the statement that if indebtedness is being retired, depreciation does not have to be accounted for, may be partially, correct. However, it would be better practice to carry a depreciation reserve and also a reserve for extensions and debt retirements on the books, the cash being applied to replacements, extensions or retirement of debt. Such a plan would allow the book records to reflect the true financial condition of the property at any time. The practice of not accounting for depreciation makes the statement of the financial position of the utility inaccurate.

Many cities have financed water systems from proceeds from general obligation bonds, and the interest and retirement charges are paid from funds acquired by taxation or by contributions from the water department to the general funds, or from both sources. Many such cities make no accounting for depreciation, nor do they keep books on any standard system of accounting. It would be much better if some uniform system of accounting were adopted by means of which depreciation and other items are accounted for in a proper manner. Under such a plan, the utility accounting can be maintained on a basis that reflects the true financial condition of the utility, and one that is not influenced by the debt situation, which varies among cities and changes from year to year in each system. Regardless of the debt structure, the utility accounting can be on a proper basis, the contribution of funds to meet debt obligations being made by cash from any reserve funds created. The point is that the accounting, so far as the utility is concerned, should be based upon the operation of the utility itself, and not governed by the financial situation that may exist as to debt service.

As stated above, it is common knowledge that depreciation in any physical plant does take place, and it would

seem to be as apparent that the loss in service value due to it should be accounted for and made a part of the cost of service. The determination of the proper amount to charge operations each year due to depreciation losses is not a simple one. The rate at which materials and equipment depreciate or suffer loss in service value differs in all utility systems. This is true so far as physical causes are concerned and to a much greater extent from those of a functional nature. A water system in a rapidly growing city will usually have more accruing losses in service value than one of slower growth. This is due to the fact that pumps, mains and other units of property become inadequate more quickly due to increased demands. Similar units of property may, and usually do, have different useful service lives in different systems. Unless a system has grown and is continuing to grow at a steady rate, and has reached an age equal to that of the unit of property having the longest useful service life in that particular property, and it can be assumed that there will be no unusual changes in the art, any data taken from the records upon which annual losses due to depreciation could be based, would not be accurate. No property in the water utility field would provide such information.

There are at present several theoretical methods in use for estimating the annual rate of accrual of depreciation and for which equivalent annual allowances are usually made. The most commonly used methods are:

1. Straight-line method.
2. Sinking-fund method.
3. Service-life-present-worth method.

The above methods call for establishing useful service lives for the different units of property involved, which at best can only be approximately correct. These service lives are usually taken from some table based upon average figures or what may appear to be average figures from some one or a few particular systems. Such average service life figures may not even approximate the actual service life of the different units in the particular property for which annual allowances are being determined. Any one of the above methods might be used as a basis for annual allowances for depreciation if the results are checked frequently and adjusted in accordance with actual accrued depreciation. The straight-line method does not give results consistent with the facts, however, since the service value of utility property does not diminish as a straight line. The sinking-fund and service-life-present-worth methods, while differing in theory, do not differ materially in results, and both recognize that, while a certain portion of the useful life has elapsed, the remaining service value is greater than indicated by the ratio of age to the estimated useful life. It is apparent that a depreciation reserve established in accordance with these theoretical methods, if not checked against an engineering determination of the actual existing accrued depreciation, may soon become considerably greater or less than it should be.

## Allowance for Retirement

Fortunately, these allowances which are made annually can be varied and the correct answer as to the correctness of the annual allowances is a periodic engineering determination of whether the balance in the retirement or depreciation reserve is adequate to cover the depreciation that has accrued in

any particular system at some fixed date. It is possible to make, within reasonable limits of accuracy, an engineering determination of the existing accrued depreciation at any certain time, based upon conditions prevailing at that time. Conditions may change later and cause the rate of diminution of service value either to increase or decrease, but for any current date, a reasonably accurate measure can be obtained for testing the adequacy of the reserve. If the amount is greater than needed, the annual allowances can be reduced, or if inadequate, they can be raised. Such a check, made periodically, gives a logical and practical method of determining what such allowances should be, as well as checking the adequacy of the reserve. The determination of proper annual allowances for retirement or depreciation and the adequacy of a retirement reserve are, from their very nature, engineering problems. Engineering appraisals of physical property are helpful in setting up a proper system of accounts, and an engineering determination of accrued depreciation is the best and only real means of knowing the actual amount of accrued depreciation existing at any fixed date.

## Represents Trust Fund

What the depreciation reserve really represents is the amount of depreciation that has taken place in the property still in service, or, expressed another way, the property that has been used up in service and for which the utility has been compensated for through rates. While it is not necessary to hold the retirement or depreciation fund in cash, as it is usually more prudent to use the money for plant extensions or debt retirement, it still is, in principle, a trust fund, held to replace the used-up property when retired, and for which the consumer has already paid. It is evident that depreciation charges that are greater than actually needed would, if reflected in rates, place a greater burden on the consumer than is necessary or fair. Likewise, charges that are too low would be unfair to the utility.

## Percentage Total Reserves

The data obtained from the survey discussed above, show that in 107 cities recognizing depreciation in their accounting system, that the total reserves in these cities is equal to 27 per cent of the total of depreciable property. This means, if that amount were justified, that 27 per cent of the depreciable physical plant still in operation had been used up in service, or, stated in another way, the physical plants have an over-all average physical and functional condition of 73 per cent. As the figure of 27 per cent is an average, some of the systems have much larger reserves. It is believed that none of the plants reporting are in such low condition, as service would probably be impaired if they were. Most of the reserves in this group of cities appear to have been influenced largely by straight-line methods of determining annual allowances. It is a good example of why the straight-line method is, as generally applied, too drastic and also illogical when compared to what actually takes place in the long-life properties. This is especially true of most water works properties. While it is good practice to have a reasonable excess in the reserve to take care of unusual and unexpected retirements, it is believed that in those 107 cities, quite a number have been accumulating reserves at a rate in excess of actual requirements.

Many water departments are faced with demands for transfer of cash to other city funds. Many of these departments could avoid serious depletion of funds if their accounting system recognized depreciation and if an adequate book reserve were maintained for retirement or depreciation, as well as an adequate cash reserve for extensions or debt retirement. Many cities carry large depreciation reserves in order to hold funds in the water department, which purpose is often justified; but it is believed that equal protection would be available through other reserve funds and the accounting be made more accurate thereby. A city may have the legal right to use funds from its utility department for other departments, but it should not do so unless the utility, by proper accounting, is shown really to have excess funds. If such excess funds exist, it would seem proper to reduce rates rather than divert funds to other departments, as such practice is really indirect taxation. Utility department officials should insist on keeping the department sound financially, and resist as far as possible the transfer of needed funds, which practice is followed in many places to the serious detriment of the department. A notice has just appeared in the press which states that in one fairly large city water rates are to be boosted $33\frac{1}{3}$ per cent, the increase being made to provide funds for postwar improvements including a sewage disposal system with, perhaps, a water softener and filter system. If the people in this city know all about what is to be done with money raised in this manner and are willing to be so taxed for it, the city no doubt has the right to adopt such a plan, and the case is only mentioned as an example of the use of utility funds for other departments.

It is hoped that soon all the water departments in the country will realize the advantages of following a uniform system of accounting and a universal recognition of the necessity of including in such systems the proper accounting for depreciation.

# A Review of the Cost of Water Works Structures

*By Charles B. Burdick*

In every well-regulated system of water works, which finances its own operations, a part of the revenues must be spent to finance new construction. This is necessary in order to keep up with improvements in the art of water supply and to meet the growing requirements of the public.

In the preparation of estimates for construction work to be done in the future, it is often necessary to make estimates of cost well in advance of definite knowledge concerning the details of the project upon which the money is to be spent. Up to the time that plans have been completed, such estimates have to be made on the basis of what similar work has cost on the particular plant in question, or elsewhere, under circumstances such as those likely to be encountered in the future.

It is the purpose of this paper to present the actual costs of water works structures covering reservoirs, water filter plant structures and pumping stations. Although many of these projects have been constructed recently, others have been well scattered over the past two decades. In order to make the data most useful for estimates, they have been placed upon a common price basis. This has been done by the use of the *Engineering News-Record* Construction Index. All data have been adjusted to the Index Number 294 which prevailed in September, 1943, and is approximately the same today.

## Engineering News-Record Index

This index has the advantage of having been published monthly on substantially the same basis for about 20 yr. The figures cover the period from 1903 up to the present time. It therefore forms a convenient basis of comparing construction costs of one period with another.

The index is made up of four factors: steel, lumber, cement and labor. These factors are weighed according to their relative importance, as follows:

(1) 25.0 × the price of structural steel per cwt. at Pittsburgh, Pa.

(2) 0.6 × the price of lumber per thousand bf. at New York.

(3) 6.0 × the price of cement per bbl. at Chicago.

(4) 200 × the price of common labor in dollars per man hour, the average of 20 cities.

The application of these factors to prices as they prevailed in the year 1913 makes the resulting index 100. Thus, in the years before and since 1913, the relative cost of construction, in general, may be shown on this basis.

Figure 1 is a plotting of the *Engineering News-Record* Construction Cost

A paper presented on June 14, 1944, at the Milwaukee Conference by Charles B. Burdick, Alvord, Burdick & Howson, Cons. Engrs., Chicago.

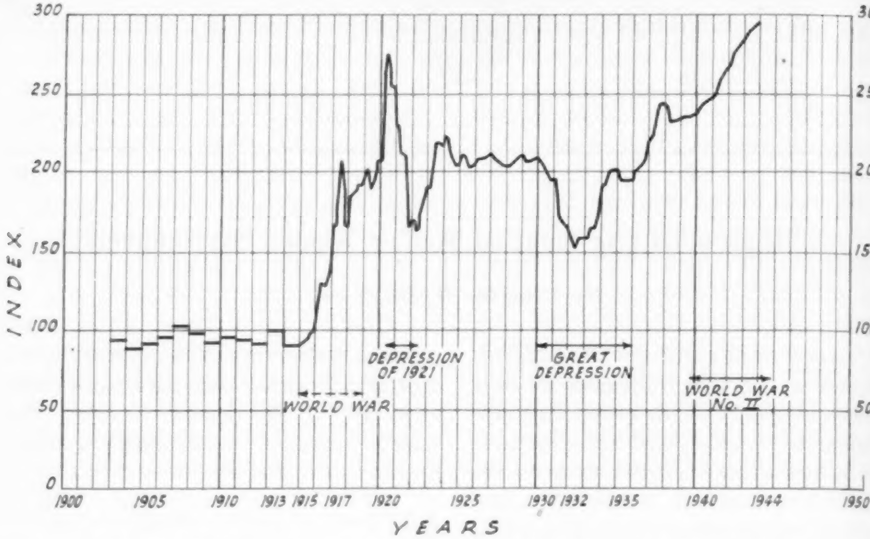


FIG. 1. Engineering News-Record Construction Cost Index Year 1913 = 100 Per Cent

Index from the year 1903 up to the end of 1943. In the years prior to 1913, the diagram shows the average figure for each year. In the years subsequent to 1913, the diagram approximates the variation in the price index from month to month during each year.

It will be noted, on examining this diagram that there was comparatively little change in the price index from the year 1903 until the year 1915, when prices began to rise in this country following the outbreak of war in Europe. The United States entered the war in April 1917, and shortly thereafter construction costs had risen substantially to double the costs prevailing in 1913, although there was a recession in the general price base near the end of 1917. Prices climbed again to a peak of about 275 in the middle of 1920. Following this peak there was a depression in 1921 when the construction index dropped to about 160. This depression was short. Prices soon rose a little above the 200 line where they continued until the financial crash in 1929 when the cost of construction work again fell, reaching about 150 in the year 1932. Since that time, the construction index has gradually increased until it now stands just below the 300 mark.

## Material Costs as Related to Labor Costs

Each type of construction might properly have an index of its own, for all prices have not varied in the same proportion to steel, lumber, cement and labor. Fundamentally however, almost all materials are closely related to the cost of labor which is becoming an increasingly important item in construction cost with each decade. Indexes have been constructed that apply to special types of construction, but no useful index can cover all the factors that enter into variations in cost. The following data, therefore, must only be considered as a general aid to judgment, modified by due consideration of the circumstances applicable to any particular case.

## Reservoirs

In nearly every water works system it is necessary to store water for emergency use, as in clear-water reservoirs connected with filtration plants or in elevated reservoirs where suitable elevated ground is available. Reservoirs are also used as settling basins in connection with the filtrations and softening of water.

Prior to about 1900, most water works reservoirs were built by excavating into the ground, using the excavated material to form an embankment, puddling the inside surface with 2 or 3 ft. of clay puddle and lining the structure with stone pavement, brick pavement or concrete, usually 6 or 8 in. thick. Such reservoirs were seldom covered. Many reservoirs of this type are in use today after more than 70 yr. of usefulness.

Shortly after 1900, reinforced concrete began to come into use for reservoirs. When the construction of large filter plants of this material became practicable, covered reservoirs—rectangular in shape, with vertical sides—were constructed to economize space, and to facilitate future enlargements. Data hereinafter presented refer to reservoirs built of concrete.

The accompanying Table 1 shows the cost of 31 reservoir projects as of the time they were built, the date of their

TABLE 1

*Cost of Concrete Reservoirs*

| Project | Type | Cost | Contract Date | Contents Mil. Gal. | Cost Per Mil. Gal. | Index When Built | Cost Per Mil. Gal. Index 294 |
|---|---|---|---|---|---|---|---|
| *Clear Water Reservoirs* | | | | | | | |
| Ironwood, Mich. | | $ 8,194 | 8/20 | 0.125 | $65,500 | 252.0 | $76,500 |
| Ashland, Ky. | | 16,390 | 10/21 | 0.5 | 32,800 | 182.57 | 53,000 |
| La Crosse, Wis. | Box, clear water, covered | 16,491 | 5/12 | 1.0 | 16,491 | 91.0 | 53,000 |
| La Crosse, Wis. | | 74,461 | 5/12 | 5.0 | 14,900 | 91.0 | 48,000 |
| Springfield, Mo. | | 70,885 | 1937 | 2.0 | 35,400 | 234.71 | 44,400 |
| Louisville, Ky. | Circular, clear water, covered | 30,900* | 10/26 | 1.0 | 30,900 | 209.80 | 43,500 |
| Knoxville, Tenn. | | 28,576 | 9/26 | 1.0 | 28,576 | 208.30 | 40,400 |
| Milwaukee, Wis., Wash tank | | 19,425 | 2/34 | 0.75 | 25,900 | 194.06 | 39,300 |
| Kenosha, Wis. | | 67,400 | 4/26 | 2.5 | 27,000 | 207.05 | 38,500 |
| Winona, Minn. | | 54,800 | 4/25 | 2.0 | 27,400 | 209.55 | 38,500 |
| Evanston, Ill. | Box, clear water, covered | 103,918† | 2/34 | 5.0 | 20,800 | 194.06 | 31,600 |
| Racine, Wis. | | 47,282 | 6/26 | 2.37 | 20,000 | 204.80 | 28,800 |
| Pekin, Ill. | | 54,800 | 7/39 | 2.5 | 21,900 | 234.94 | 27,400 |
| Denver, Colo. | | 173,000 | 11/35 | 10.0 | 17,300 | 194.90 | 26,200 |
| Paducah, Ky. | | 85,950 | 11/35 | 5.0 | 17,200 | 194.90 | 26,000 |
| Lansing, Mich. | Circular, clear water, covered | 55,730 | 9/18 | 3.5 | 16,000 | 193.85 | 24,300 |
| Knoxville, Tenn. | | 152,765‡ | 3/26 | 10.0 | 15,276 | 207.65 | 21,600 |
| Milwaukee, Wis. N. Clear well | Box, clear water, covered | 130,233 | 3/35 | 9.55 | 13,600 | 194.26 | 20,600 |
| S. Clear well | | 101,587 | 3/35 | 7.96 | 12,750 | 194.26 | 19,400 |
| Louisville, Ky. | | 305,489 | 6/31 | 30.0 | 10,200 | 187.23 | 16,100 |
| Mill Creek, Ohio | Earth wood, covered | 207,924 | 9/42 | 15.0 | 13,850 | 281.61 | 14,400 |
| *Coagulating Basins* | | | | | | | |
| Ashland, Ky. | Coagulation basins, covered | 23,652 | 10/21 | 0.55 | 43,000 | 182.57 | 69,400 |
| Racine, Wis. | Coagulation box, covered | 70,000 | 6/24 | 1.8 | 39,000 | 216.85 | 52,800 |
| Racine, Wis. | Coagulation basins, covered | 97,000 | 11/38 | 2.43 | 40,000 | 234.40 | 50,200 |
| Springfield, Mo. | | 74,770 | 1937 | 1.9 | 39,400 | 234.71 | 49,400 |
| Laredo, Tex. | Coagulation, cir., open | 34,351 | 7/27 | 1.67 | 20,600 | 203.68 | 29,700 |
| Cedar Rapids, Iowa | Coagulation, square, open | 65,525 | 6/29 | 3.17 | 20,700 | 205.65 | 29,600 |
| Knoxville, Tenn. | Coagulation, earth, open | 93,523 | 3/26 | 5.0 | 18,700 | 207.65 | 26,400 |
| Denver, Colo. | Coagulation box, covered | 143,900 | 11/35 | 8.8 | 16,300 | 194.90 | 24,600 |
| Milwaukee, Wis. S. Coagulation basin | Box, 2 story, covered | 254,710 | 3/35 | 21.54 | 11,850 | 194.26 | 18,000 |
| N. Coagulation basin | | 254,710 | 3/35 | 21.54 | 11,850 | 194.26 | 18,000 |

* Exclusive of rock excavation. † Includes breakwater. ‡ Before repair.

construction, water contents of the reservoir, the cost per million gallons as of the time built, the *Engineering News-Record* price base when built, and the cost per million gallons reduced to the price base of Index 294 which prevailed in September 1943, and which is substantially the price base at present.

Figure 2 is a logarithmic scale plotting of the size of each reservoir expressed in million gallons capacity and the cost per million gallons on the present price base. An examination of this diagram shows at once, as would be expected, that the larger reservoirs can be constructed at a lower cost per million gallons capacity than the smaller reservoirs. It also shows that there is considerable difference in the cost of different jobs even though they are reduced to the same basis of price. Some of the reasons for the variations can be explained, but some are only explainable on the basis of the conditions that govern the prices bid at the time the work was done.

Most of these reservoirs are of the so-called box type construction—the bottoms are substantially flat, the sides are substantially vertical and, in most cases, each is covered by a reinforced concrete roof surmounted by about 1 ft. of earth, although more earth was used in some cases, particularly where weight was desirable to counteract upward pressure.

In a few cases on the diagram, reservoirs of special construction are shown. Thus, the Mill Creek Reservoir, with a capacity of 15 mil.gal., is comparatively low in cost, although it was a war job built in a great hurry. It is a rectangular structure with sloping earth embankments, the bottom and side of which were puddled to increase watertightness and covered with 6 in. of concrete as a pavement, the whole surmounted by a wooden roof supported on wooden posts.

In a few cases the diagram shows circular reservoirs, as in the case of the 1.6-mil.gal. circular basins at Laredo, a 1-mil.gal. circular reservoir at Knoxville and a similar reservoir at Louisville. As would be expected, the circular form of reservoir is slightly lower in cost per million gallons than the rectangular form.

Generally, where a reservoir is used as a coagulation basin, it contains more division walls than are commonly built in storage reservoirs and usually more in the way of sluice gates to control the flow. It will be noted, however, that quite as many coagulation basins or settling basins fall below the average line as fall above it, each coagulation job being noted by an appropriate symbol on the diagram.

Figure 3 shows the number of yards of concrete per million gallons capacity for most of the reservoirs shown on Table 1 and the pounds of steel per cubic yard of concrete in the respective reservoirs.

It will be noted that the number of yards of concrete per million gallons capacity decreases in some function of the size of the reservoir, but that the "pounds-of-steel-per-cubic-yard" is practically independent of reservoir capacity. It will also be noted that there is some considerable variation in the yards of concrete per million gallons capacity. This is due in part, to foundation conditions and in part due to prevalence of upward pressure and the necessity for thickening the floor and the roof. Upon soft foundations it is sometimes necessary to spread the column load as uniformly as possible over the whole floor area, whereas in other cases, upon a hard bottom, small

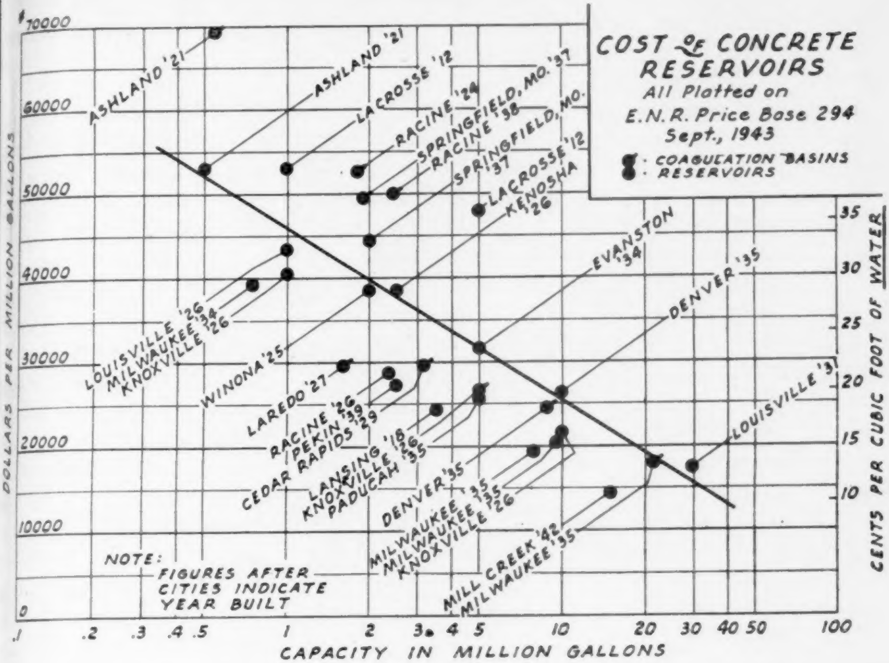


FIGURE 2

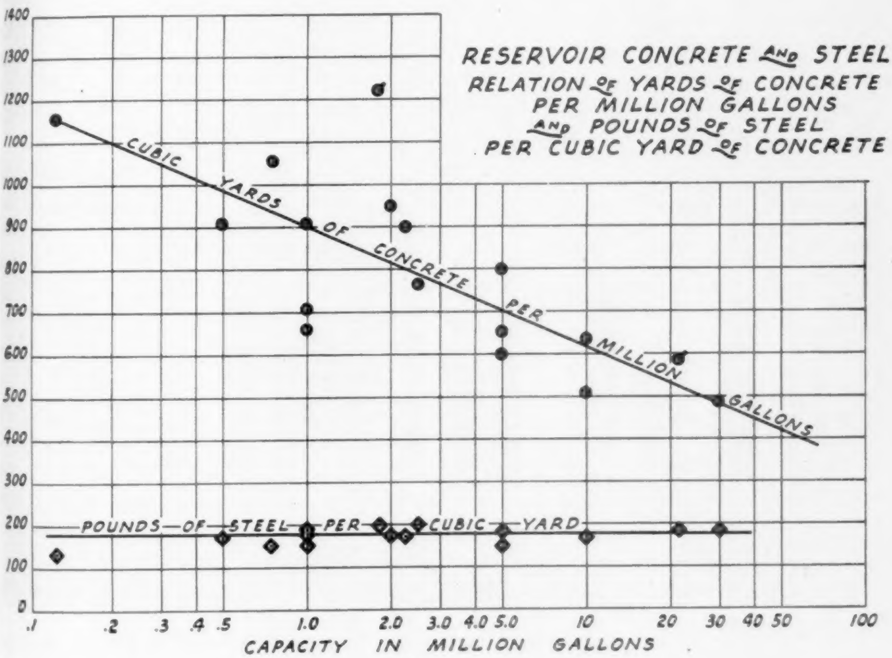


FIGURE 3

column footings are practicable, with the major part of the floor having a nominal thickness only.

Most of these jobs have been designed on the basis of 16,000 psi. tension in the steel and 650 psi. compression in reinforced concrete. Recently, 18,000 psi. and 800 psi. have been used. The Milwaukee project was designed for 20,000 psi. stress in the steel and 1,000 psi. compression in the reinforced concrete (Fig. 4). All these reservoirs have been reinforced for temperature stresses. The horizontal steel in the walls has generally been 0.4 of 1 per cent at the top of the wall and about 0.2 of 1 per cent at the base of the wall for walls ranging from 16 to 20 ft. in height. Roof slabs and floor slabs are designed to absorb the thrust of the walls with at least 0.2 of 1 per cent of steel added to provide for temperature stresses.

## Tests for Leakage

The reservoirs have usually been tested for leakage immediately after completion. At this time, a well-built reservoir, when filled with water, will show a water drop of $\frac{1}{8}$ in. or less within a period of 24 hr. Usually the reservoir is allowed to stand full for a few days before a test is made. In some cases, particularly in the early reservoirs, a greater leakage was observed on test and contractors were required under specification requirements to make repairs until substantially the figure above named was secured.

With one exception, all the reservoirs shown on this diagram were built as monoliths without expansion joints.

FIG. 4. Interior of One of the Large Clear Water Storage Reservoirs at the Milwaukee Filter Plant

TABLE 2

*Cost of Filter Plant Buildings*

| | Capacity of Plant Mgd. | Cost | Contract Date | Cubic Feet | Cost per cu.ft. | Price Base When Let E.N.-R. | Cost per cu.ft. Sept. 1943 Index 294 | Included | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Mixing | Settling | Head House | Filters | Clear Res. |
| Milwaukee, Wis. | 200.0 | | | | | | | | | | | |
| Foundation Front Bldgs. | | $ 232,172 | 7/36 | 577,000 | 40.2 | 204.40 | 57.7 | | | | | |
| Superstructure Front Bldgs. | | 497,185 | 7/37 | 1,265,000 | 47.2 | 241.75 | 57.5 | | | | | |
| Filter House and Head House Complete | | 1,708,907 | — | 7,534,000 | 22.6 | 217.00 | 30.6 | | | X | X | X |
| Filter Superstructure | | 418,241 | 3/36 | 2,025,000 | 20.7 | 201.20 | 30.2 | | | | | |
| Filters and Reservoir, under | | 461,309 | 8/35 | 3,667,000 | 12.6 | 195.10 | 19.0 | | | | | |
| *Western Springs, Ill. | 1.5 | 49,800 | 6/31 | 146,600 | 34.0 | 187.23 | 53.5 | X | X | X | X | X |
| *La Grange, Ill. | 3.0 | 60,217 | 9/38 | 147,500 | 40.8 | 232.70 | 51.6 | X | X | X | X | |
| *Cedar Rapids, Iowa | 12.0 | 233,000 | 7/29 | 652,600 | 35.8 | 204.77 | 51.5 | | | X | X | X |
| New Albany, Ind. | 4.0 | 19,500 | 11/15 | 127,600 | 15.3 | 101.06 | 44.5 | | | X | X | |
| Kenosha, Wis. | 6.0 | 44,372 | 6/28 | 144,000 | 30.8 | 206.15 | 44.0 | | | | X | X |
| Laredo, Tex. | 6.0 | 52,918 | 7/27 | 173,900 | 30.4 | 203.68 | 44.0 | | | X | X | X |
| Racine, Wis. | 12.0 | 133,122 | 2/26 | 432,000 | 30.8 | 206.55 | 44.0 | | | X | X | |
| *Bloomington, Ill. | 5.0 | 210,000 | 3/29 | 700,200 | 30.0 | 207.78 | 42.4 | X | X | X | X | X |
| Denver, Colo. | 40.6 | 313,800 | 3/36 | 1,153,500 | 27.2 | 201.20 | 39.8 | | | X | X | |
| *Columbus, Wis. | 0.71 | 9,988 | 11/32 | 47,160 | 21.1 | 158.20 | 39.2 | X | X | X | X | |
| Sheboygan, Wis. | 12.0 | 238,710 | 8/29 | 894,000 | 26.8 | 205.91 | 38.4 | X | X | X | X | X |
| *Glencoe, Ill. | 3.0 | 124,500 | 6/26 | 498,600 | 25.0 | 204.80 | 36.0 | X | X | X | X | X |
| *Waupun, Wis. | 1.0 | 29,451 | 2/35 | 122,400 | 24.0 | 196.02 | 36.0 | X | X | X | X | |
| *Neenah, Wis. | 2.0 | 87,330 | 7/36 | 358,000 | 24.4 | 204.40 | 35.0 | X | X | X | X | X |
| Louisville, Ky. | 48.0 | 264,000 | 10/26 | 1,070,000 | 24.6 | 209.80 | 34.5 | | | | X | |
| Knoxville, Tenn. | 15.0 | 340,357 | 3/26 | 1,470,000 | 23.2 | 207.65 | 32.8 | X | | X | X | X |
| *Miami, Fla. | 10.0 | 117,878 | 9/24 | 556,000 | 21.2 | 211.25 | 29.6 | | | X | X | |

* Softening Plants.

It is practically impossible to build a large reservoir that will be entirely free from cracks if the concrete work is done in the warm season of the year. However, if the concrete is well reinforced, these cracks will be comparatively small. They are usually vertical cracks in the side walls, some of which become visible immediately on removal of forms, despite efforts to keep all concrete work moist and as cool as possible by flooding the flat work and the use of burlap covering kept constantly wet on side walls.

Nearly all the reservoirs shown have reinforced concrete roofs surmounted by earth fill which also covers the side walls. Under such conditions, reinforced concrete has quite a long life.

## Filter Plant Structures

It is convenient to estimate the size of buildings by the cubic foot, and it is the most common practice to use the exterior cubic footage from average height of foundation to average height of roof, figuring the cubic footage for each part of the building separately and adding the same together.

In building water filtration plants, the filters, filter house, head house, foundation and sometimes the mixing and coagulation basins are quite frequently let in one contract.

Table 2 shows the costs of 18 filter plant buildings with accompanying structures together with the contract date, cubic footage, cost per cubic foot when let, price base when let (*Engi-*

*neering News-Record* price base) and what the present cost per cubic foot would be if reduced to the present price base of approximately 294. The last column in the table shows the items of work that are included in each contract cost.

## Building Costs Diagrammed

Figure 5 shows the present costs per cubic foot plotted upon a logarithmic scale as indicated in Table 2.

is a comparatively low cost plant for another reason, namely, because it is tropical construction in which neither the filters nor the settling basins are covered.

## Pumping Stations

Most of the pump housings are now built in connection with the construction of filtration or softening plants in which they are included in the filter plant structures. Table 3 shows the

TABLE 3

*Cost of Pumping Station Buildings*

| | Cost | Contract Date | Cubic Feet | Cost per Cu.ft. | Price Base When Let E.N.-R. | Cost per Cu.ft. Sept. 1943 Index 294 |
|---|---|---|---|---|---|---|
| *Pumping Stations* | | | | | | |
| Brookfield Zoo Movable Well House | $ 4,160 | 3/38 | 4,990 | 83.5 | 238.80 | 103.0 |
| Ironwood, Mich. 2 (Sub.) each | 4,822 | 7/20 | 7,500 | 64.2 | 265.70 | 71.0 |
| Louisville, Ky. (addition) | 94,900 | 10/26 | 210,000 | 45.2 | 209.80 | 63.5 |
| Des Moines (Booster Station) Iowa | 17,700 | 10/41 | 35,300 | 50.0 | 264.50 | 55.7 |
| Racine, Wis. | 158,925 | 7/31 | 530,600 | 30.0 | 174.37 | 50.5 |
| Ironwood, Mich. (Main) | 29,155 | 7/20 | 65,000 | 44.8 | 265.70 | 49.5 |
| Ashland, Ky. | 34,194 | 10/21 | 130,000 | 26.4 | 182.60 | 42.5 |
| Des Moines (21st St.) Iowa | 220,479 | 9/21 | 810,000 | 27.2 | 188.30 | 42.5 |
| Prairie du Chien, Wis. | 21,017 | 9/21 | 77,800 | 27.0 | 188.30 | 42.3 |
| La Crosse, Wis. | 50,834 | 11/12 | 484,000 | 10.5 | 100.00 | 30.9 |
| Orlando, Fla. | 91,800 | 9/22 | 510,000 | 18.0 | 185.00 | 28.6 |
| *Auxiliary Buildings* | | | | | | |
| Des Moines (Warehouse) Iowa | 18,754 | 5/22 | 111,000 | 16.8 | 164.6 | 30.0 |
| Des Moines (Garage) Iowa | 51,027 | 5/22 | 390,000 | 13.1 | 164.6 | 23.4 |

On this diagram, two lines have been drawn designated as Type A and Type B. Type A covers the more recent large plants with modern construction throughout. The line designated as Type B closely approximates the cubic foot costs of three small softening plants in which the type of construction is not quite as good as in the case of the filter plants designated under Type A.

It is noted however that the Miami plant, which is also a softening plant,

cost of 13 water works pumping stations varying from large to small. This table shows the original contract costs, the contract date, the cubic feet, the cost per cubic foot when built, the *Engineering News-Record* price base at the time when built, and the cost per cubic foot, as of the present time.

Figure 6 is a plotting of these cubic foot costs. It clearly illustrates the great difference in the cubic foot cost of large buildings and small buildings, as was the case in connection with the

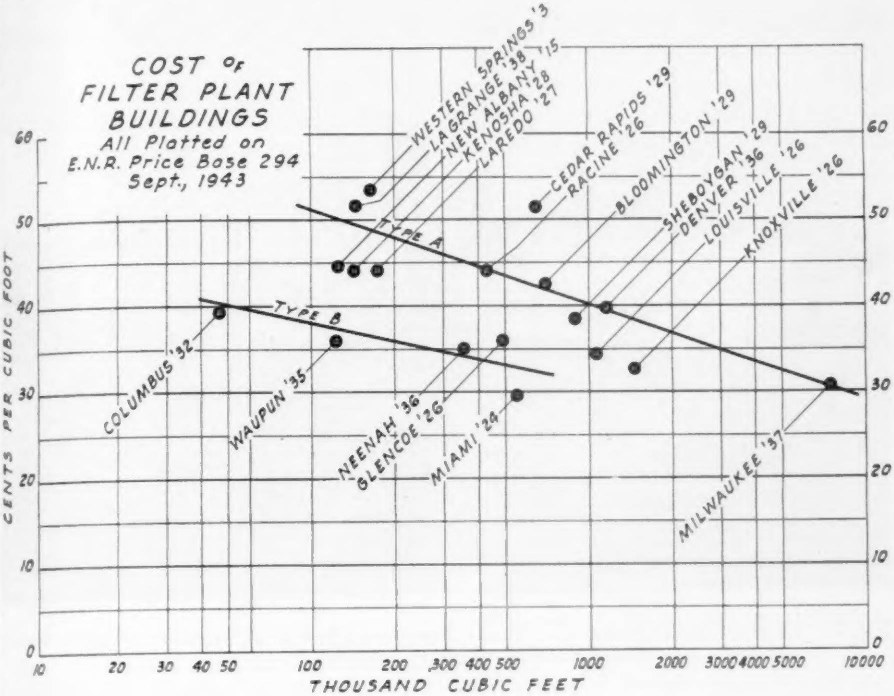


FIGURE 5

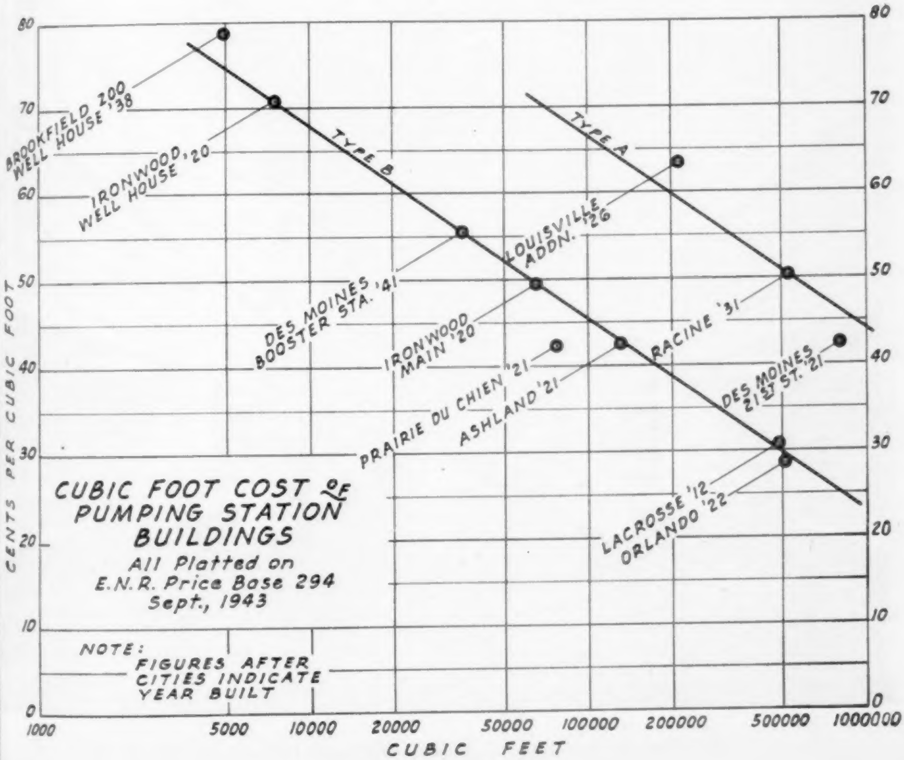


FIGURE 6

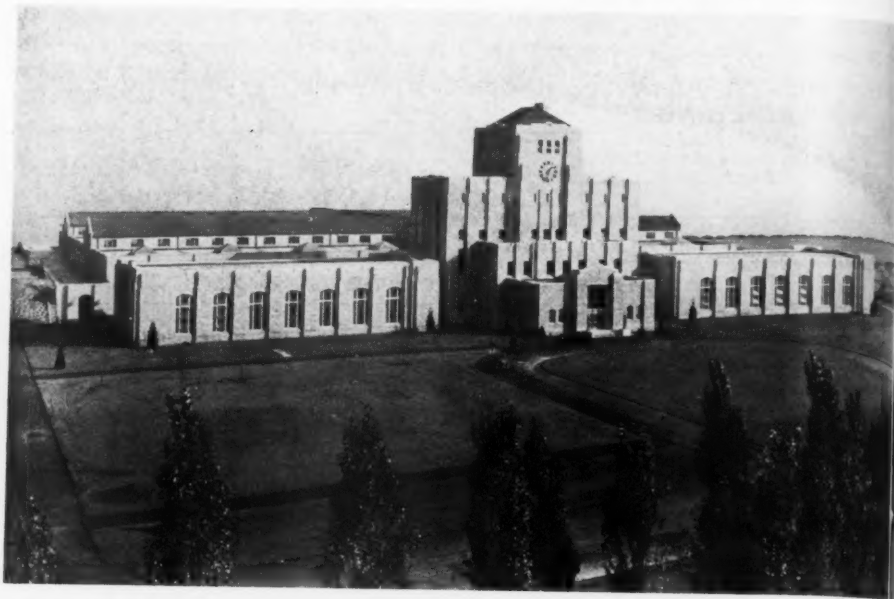

FIG. 7. Exterior View 20-Mil. Gal. Water Filtration Plant at Milwaukee. Settling Basins and Clear Water Reservoirs Are Constructed Beneath the Lawns

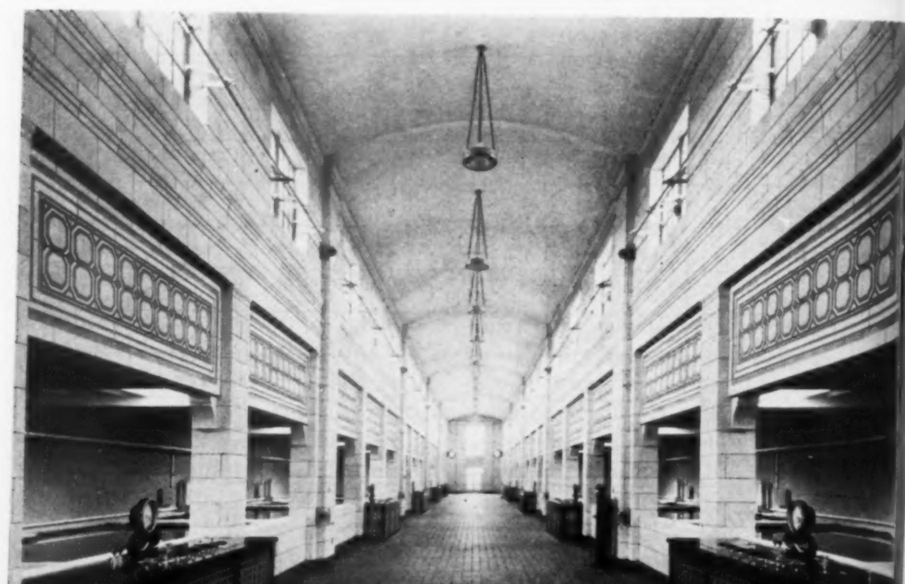

FIG. 8. Operating Gallery Denver Water Filtration Plant, Capacity 40 Mgd.

filter plant buildings and reservoirs, although the difference is more marked in this table because some very small well houses have been included which require a very high price per cubic foot.

Two lines have been drawn upon this diagram. Type A stations are better finished than the stations typified by the line marked Type B. The Type B stations have, in general, painted brick interiors except in the principal rooms where pressed or texture brick has been used. In the stations approximating the line Type A, enamel brick and tile have been extensively used in interiors.

The accompanying photographs (Figs. 7, 8) illustrate some of the differences that have been mentioned in connection with the pumping station buildings and filtration plant buildings.

## Present and Future Costs

Estimates for construction work to be done at the present time are very difficult to make. Any construction work is likely to be considerably more expensive than would be indicated by the price base of labor and materials. This condition arises from the fact that materials and labor are difficult to obtain, the hazards of lump sum contracts are great, and profits if made are likely to be taken away from a contractor through taxation. It is not a condition where contractors are justified in taking work under comparatively small margins of profit, which has usually been the case over the past 30 yr. except during the interruption to the orderly conduct of the construction work during the previous World War.

It is assumed that the time will come after the war is over when an ample reserve of skilled labor and material will be available, at which time building construction can be expected to resume its orderly course.

What will happen to the price base after the war is difficult to predict. In general, the costs of labor and material have continued to increase, with ups and downs, for a century or more.

# Survival and Retirement Experience With Water Works Structures

## A Committee Report

### *By E. H. Aldrich*

THE formation and work of the Committee on Survival and Retirement Experience With Water Works Facilities resulted from many requests for factual information relating to the actual life in service of the many items of property making up a water system. These requests came from those who are interested in the management and operation of water companies, from municipal and financial administrators and from utility regulatory bodies. An important stimulus to the committee's work was the fact that, at the time of its inception, the National Association of Railroad and Utilities Commissioners, a body composed of representatives from the various utility regulatory commissions, was at work, through a special committee, revising and preparing a complete and thorough treatise on depreciation. This special committee invited the several branches of the utility industry to submit factual data which would represent the actual length of life of utility property in service. The depreciation report of the NARUC Committee has been published in preliminary form.

The S & R Committee, as it has come to be known, was authorized by the Board of Directors of the American Water Works Association at its January 1941 meeting and promptly commenced the collection of such factual information as would indicate the actual lives of facilities pertaining to water works systems. Subsequently the New England Water Works Association voted to join in the study and appointed a committee to co-operate with that of the A.W.W.A. The committee has had, since beginning work, the co-operation and financial support of the Institute of Water Supply Utilities.

Approximately 35 representative cities in the United States and Canada, some having municipally-owned and others having privately-owned water utilities, were invited to contribute their personnel and expenses to canvass records of installations and retirements of property units and abstract the required information. With few exceptions, these cities and companies generously agreed to furnish and fund the personnel required to compile the records of installation and retirement

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A report presented on June 14, 1944, at the Milwaukee Conference by E. H. Aldrich, Cons. Engr., New York, N.Y., and Supervising Co-ordinator, Committee on Survival and Retirement Experience With Water Works Facilities.

of property which were necessary to determine the actual facts indicating the lengths of lives, the survivals and the reasons for retirements of facilities in their plants.

### Factual Information Valuable

The results of a study such as the committee entered into have a variety of uses. In addition to the use of mortality studies as an element in the determination of depreciation and, therefrom, the value of plant for rate, tax or purchase and sale purposes, or to determine cost of service to consumers outside municipal boundaries, there may be mentioned the use of property lives to forecast more intelligently the length of bond issues, to make plans for required replacement programs, to determine the economic use of competing materials or equipment and to indicate whether increased maintenance or replacement is advisable. It will be increasingly relied upon as a result of changes which are already occurring in the operating, managing and financing of water supply utilities. The problems arising from these changes will affect municipal and private water utility departments to an increasing degree in the future and departments which have adequate survival retirement records will find them well worth while.

Generally speaking, water plants are in the process of passing from an era of expansion, which has been required in the past to keep pace with the rapid growth in population, to one of stabilized operation serving relatively static communities. Proper evaluation of past performances and the differences to be anticipated under the future changed conditions can be made only when the records of the past are compiled in usable and comparable form.

Briefly, it might well be of record value to describe the organization of the committee, the object of its work and the general method in which it was carried forward.

### Committee Organization

Mr. Louis R. Howson, A.W.W.A. Past President, is Chairman of the Committee, which is made up of the following membership: J. Walter Ackerman, Munnsville, N.Y.; Herbert H. Brown, Milwaukee, Wis.; Carl A. Eberling, Cincinnati, Ohio; Nelson A. Eckart, San Francisco, Calif.; John C. Flanagan, St. Paul, Minn.; Harry U. Fuller, Portland, Me.; George F. Hughes, Denver, Colo.; H. H. Hyman, Miami, Fla.; Samuel E. Killam (deceased), Boston, Mass.; Paul M. Kydd, New York, N.Y.; L. G. Lenhardt, Detroit, Mich.; W. E. MacDonald, Ottawa, Ontario; Dale L. Maffitt, Des Moines, Iowa; Samuel B. Morris, Palo Alto, Calif.; Ben S. Morrow, Portland, Ore.; John H. Murdoch Jr., New York, N.Y.; Reeves Newsom, Scarsdale, N. Y.; B. E. Payne, Louisville, Ky.; Walter M. Scott, Winnipeg, Manitoba; M. S. Smith, Richmond, Va.; H. A. Van Norman, Los Angeles, Calif.; and Thomas H. Wiggin, New York, N.Y.

The committee's work was largely directed by an Executive Committee of the whole, consisting of the Chairman, Mr. Howson, and Messrs. Lenhardt, Maffit, Newsom and Wiggin.

The author was employed by the Committee as Supervising Co-ordinator to act for it in co-ordinating the efforts in the various co-operating systems and in assembling and compiling the information received. He has visited each city one or more times to examine the records and to assist the local men in doing the detail work.

## Object

The object of the committee's activities was to collect into readily available and useful form, statistics regarding the lives of the principal elements of water works systems that have been retired and the ages of facilities which were still in service. Further than determining the number of years of service which have been rendered by items of property which have been replaced or abandoned, this study included the determination of the number of years which have been survived by elements of plants still in service. It has also attempted, without complete success, to record the conditions which have caused retirements and to determine the amount of salvage realized.

## Scope of Work

The scope of the work has included, generally, the collection of records relating to the chief facilities used in water plants, which reveal the number and length of life of such facilities as have been used and retired, the number and age of those still in service and the distribution by ages throughout the life span.

Water works facilities lend themselves generally to division into two groups, one consisting of items of like kind occurring in large numbers in all plants, and the other consisting of those few individual units in a system which are influenced as to type, size and length of useful life by the particular conditions under which they operate. These facilities, for the purpose of the committee's work, have been classified as follows:

*Class A Facilities*

| | |
|---|---|
| Mains | Services |
| Valves | Hydrants |
| Meters | |

*Class B Facilities*

Dams and Reservoirs
Tunnels and Aqueducts
Wells and Collecting Galleries
Distribution Reservoirs
Standpipes and Elevated Tanks
Pumping Equipment
Purification Plants

The following table gives briefly the scope of the committee's program as planned and the results accomplished in Class A facilities. Table 1 gives in more detail the cities where studies have been made and the number and facilities studied. The information assembled on Class B facilities is incomplete, but such as was collected is incorporated in the reports.

*Scope of Committee Activity*
*(Figures Rounded)*
*Class A Facilities*

| | *Planned* | *Completed* | *Incomplete* |
|---|---|---|---|
| Cities | 35 | 25 | 10 |
| Total population | 10,000,000 | 4,700,000 | 5,300,000 |
| Mains—*mi.* | 20,000 | 8,000 | 12,000 |
| Valves | 30,000 | 20,000 | 10,000 |
| Meters | 1,000,000 | 178,000 | 822,000 |
| Services | 900,000 | 160,000 | 740,000 |
| Hydrants | 80,000 | 13,000 | 67,000 |

In addition to the work outlined in the cities given in Table 1, there was planned, and in certain instances the cities have completed, some work in Brooklyn, N.Y.; Louisville, Ky.; Detroit, Mich.; Los Angeles, Calif.; Madison, Manitowoc and Milwaukee, Wis.; Miami, Fla.; Cincinnati, Ohio; and Richmond, Va. The wide difference in the work planned and completed, as far as quantities of units are concerned, is due primarily to not having completed the work in Los Angeles and Detroit, two of the largest cities in the program which, between themselves, have nearly 50 per cent of the

number of facilities which it was proposed to study.

Out of 35 cities having a population of about 10,000,000 where studies were planned to be made, this report includes those on 25 cities, covering a population of nearly 5,000,000. When it is realized that the projected program of the committee's work covering the facilities studied constitutes nearly one-eighth of the total of all similar items in the United States and Canada and the mileage of mains would nearly encircle the globe at the equator or reach six times the distance from New York to Los Angeles, the extent of the projected work can be better visualized. The records abstracted and studies made included 8,000 mi. of main out of 20,000 mi. planned, 20,000 valves out of 30,000, 178,000 meters out of 1,000,000, 160,000 services out of 900,000 and 13,000 hydrants of a total of 80,000 originally planned.

It was the aim of the committee to have the list of cities studied include various sizes and types of plants from various sections of the country.

TABLE 1

*Summary of Cities and Facilities Studied*
*Class A Facilities*
*(Rounded Figures)*

| | Mains | | Valves | Meters | Services | | Hydrants |
|---|---|---|---|---|---|---|---|
| | ft. | mi. | each | each | each | ft. | each |
| (M) Springfield, Mass. | 2,197,000 | 415 | | | | | |
| (M) Utica, N.Y. | 1,021,000 | 193 | | 22,030 | | | 1,730 |
| (M) Philadelphia, Pa. | 13,082,000 | 2475 | | | | | |
| (M) Des Moines, Iowa | 2,082,000 | 394 | 2,590 | 40,700 | | | 3,730 |
| (M) Ottawa, Ont. | 1,140,000 | 216 | | 2,910 | | | |
| (P) Scranton, Pa. | 1,174,000 | 222 | | | | | |
| (P) Alexandria, Va. | 336,000 | 64 | 450 | | | | |
| (P) Clinton, Iowa | 180,000 | 34 | | | | | |
| (P) Huntington, W.Va. | 891,000 | 169 | | | | | |
| (P) St. Marys, Pa. | 153,000 | 29 | | 1,990 | | | 90 |
| (P) Commonwealth, N.J. | 1,700,000 | 322 | 2,520 | | | | |
| (M) Portland, Me. | 1,423,000 | 270 | | | | | |
| (M) San Francisco, Calif. | 1,361,000 | 258 | | | | | |
| (M) Winnipeg, Man. | 1,750,000 | 332 | | 42,170 | | 1,331,600 | |
| (M) Denver, Colo. | 6,225,000 | 1181 | 12,400 | | 75,560 | | 4,910 |
| (P) Jamaica, N.Y. | 3,453,000 | 653 | | | | | |
| (P) Babylon, N.Y. | 230,000 | 44 | 300 | | | | 390 |
| (P) Merrick, N.Y. | 223,000 | 42 | 520 | | | | 620 |
| (P) Norwich, N.Y. | 134,000 | 25 | 280 | | | | 170 |
| (P) Sag Harbor, N.Y. | 41,000 | 8 | 70 | | | | |
| (P) Syracuse (Sub.) N.Y. | 303,000 | 57 | 370 | | | | 210 |
| (P) Rochester (Sub.) N.Y. | 530,000 | 100 | 820 | | | | 790 |
| (P) Clyde, N.Y. | 42,000 | 8 | 30 | | | | 90 |
| (M) W. Palm Beach, Fla. | 405,000 | 77 | | | | | |
| (M) St. Paul, Minn. | 3,339,000 | 632 | | 68,490 | | | |
| Total | 43,415,000 | 8220 | 20,350 | 178,290 | 75,560 | 1,331,600 | 12,730 |

(M) Municipal System. (P) Private System.

Because of the tremendous amount of detail tabulation work required, a study such as this takes a large amount of time and effort. Much has been accomplished, but a great deal of work remains to be done to complete the original program laid down by the committee. War activities have, of necessity, restricted and slowed down, and in some cases stopped, the efforts of those cities actively involved therein.

## Record Forms

To secure the results desired in comparable shape there were provided for those companies who desired to use them, two basic record forms for compiling the data regarding Class A facilities.

The first consisted of cards upon which were recorded on one side the installation of similar items by years and upon the reverse the amounts and dates of retirements of those items appearing on the face of the card.

The second was a tabular form properly identified by title for each class of facility upon which was summarized, with a line for each year of original installation and spaces for identification of retirements, the data collected on the cards.

Facilities were classified by material of composition, type of construction or assembly or by manufacturer. Sets of cards and summary sheets for each class of facility were provided.

Class B facilities, generally being installed and retired as individual units, required individual summary sheets for each type of facility to record on them general descriptions and other pertinent data properly to identify the structure, its type, size, material of construction and, when retired, the reasons dictating the necessity for retirement.

## Summarizing of Data

The summaries of the records compiled in each city were forwarded to the office of the Supervising Co-ordinator, where they were rearranged in a form satisfactory for the computation of the mortalities of the particular facility studied. From the mortality computation sheets mortality survival curves were drawn to show in graphic form the results of the study.

In an effort to place the results of the committee's work before the Association as soon as possible, this report has been compiled from the material secured up to the present date and will be published in the JOURNAL. While the committee's work thus may be considered as final, so far as the reports now completed are concerned, there are several cities still working on the abstraction of their records and it is hoped that the usefulness of the committee's work will be continued by subsequent compilation and presentation of additional information as it becomes available.

The full report, to be printed in the JOURNAL or separately as soon as practicable, will include substantially all of the summarized data from each city. It will consist of a short report covering the history and general description of each system, with summaries of the facilities, the records of installation and retirement which were compiled and studied in each city. Insofar as determined, tables will be given showing the causes of retirement and any salvage realized. The mortality survival curves computed from the information compiled will be shown in the report on each city. The basic mortality computation sheets, from which the mortality survival curves were determined, will be included in an appendix to the report.

This Report of the Committee on Survival and Retirement Experience With Water Works Facilities, covering studies in 25 cities, will consist of some 250 pages of general description and summaries and, in addition, will include 65 mortality survival curves based on 260 separate mortality computations.

The collection and compilation of data in each of the co-operating cities was done in all cases by the personnel of the local water utilities except in the cases of Springfield, Mass.; Utica, N.Y.; and Philadelphia, Pa., which were compiled by or under the direction of the Supervising Co-ordinator. The preparation and computation of the mortality survivals and mortality survival curves were carried out in the office of the Co-ordinator.

The co-operation of the individual members of the committee in those cities where the work was actively prosecuted has been excellent. It is impossible accurately to estimate the numbers of man hours which have entered into the searching of the records and compilation of the results, but they have been exceedingly large. One city alone, Detroit, has expended over $12,000 on its still uncompleted compilation of records. The aggregate expenditures by participants may well run over $100,000. Without the generous donation of this labor by the co-operating members of the Association who were engaged in the work of the committee, this report could not have been possible. It is proper that the appreciation of the Association should be conveyed to the committee members and the personnel of those cities and companies who have so generously given their time and effort to this very important work.

# Mobilizing the Utilities for War

*By Edward Falck*

IN June of each year during the war period, you have arranged to have representatives of the War Production Board meet with you and discuss the over-all problems in which we are jointly interested. However, the real work of the Board is not accomplished in conferences quite as large as this one. Usually we get together with industry representatives to work out the details of WPB orders and regulations. In our efforts to be sure that the advisory group is representative, we have often increased the size of the meetings, but we have never, as yet, had a committee numbering 1,500.

I will not undertake to explain to you the complicated features of Utilities Order U-1. Instead I will try to give you a general picture of the job that has been done to mobilize utilities, outline the present situation and the changes that may be expected during the coming year.

All of our thoughts are now concentrated on the great battles that are being fought in France, Italy and in the seas and islands of the Pacific Ocean. We are proud to know that our Army, Navy and Air Forces have at their disposal the largest and best fighting equipment ever produced by any nation in the history of the world. The amazing production job which has been done in this country has resulted from unprecedented co-ordination between industry, labor and the government. All of our resources and energies have been thrown together into one single integrated undertaking and no important segment of the American economy has failed to make its essential contribution. While the job that has been done in producing munitions and weapons is well known to everyone, it is possible that many people have failed to recognize the important role which the utilities have played in war production.

Tremendous quantities of utility-type equipment are required directly by the military services—turbines and propulsion equipment for the Navy; radio and radar equipment for land, sea and air forces; power, water and telephone equipment for overseas use. The utilities themselves have been called upon to supply utility services to meet the ever increasing requirements for the production of raw materials and industrial products, for factories and military establishments and for war housing and other essential civilian activities.

As an illustration of the size of these war requirements in the water field, it takes 75 tons of water to produce 1 ton of ingot steel; 100 gal. of water to product 1 gal. of industrial alcohol; 130 gal. to produce 1 lb. of synthetic

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An address presented on June 14, 1944, at the Milwaukee Conference by Edward Falck, Director, Office of War Utilities, War Production Board, Washington, D.C.

rubber and 125,000 gal. of water to test a single airplane engine. Similarly, in the field of communications it takes 12,000 telephone calls to build an average bomber and 63,000 telephone calls to build a Liberty Ship.

In order to meet military schedules and to assure the uninterrupted supply of utility services during the war, it was necessary to set up a large temporary governmental organization—the War Production Board. This board includes separate agencies or divisions responsible for every segment of American industry. The Office of War Utilities is the agency created within the WPB for the purpose of exercising the board's wartime powers and responsibilities in the field of public utilities—electric, power, natural and manufactured gas, water, wire communications and central steam heating—as well as in the field of utility equipment manufacture. The OWU operates on a semi-autonomous basis, comparable to the Petroleum Administration for War, the Office of Rubber Director and the Office of Defense Transportation.

Today the OWU is an established and smoothly operating organization. It has a charter from the chairman of the WPB authorizing it to exercise directly virtually all of the WPB's power in the public utility and equipment manufacturing areas for which it is responsible; a staff of approximately 400 employes; an annual budget of about $1,130,000; some 14 Industry Advisory Committees on which more than 150 utility and business leaders serve without compensation; harmonious and effective working arrangements as to jurisdiction with other government agencies, and an administrative-legislative framework of orders governing the flow of materials for maintenance, repair, operating supplies and construction; the scheduling of equipment production and the curtailment of service during periods of shortage.

This was not always so. At the outset there was no staff, there were no orders and there was no established working relationship with industry or with other governmental agencies. The job to be done was totally undefined. Looking backwards, it is possible to identify the basic principles which have contributed to building up the organization and getting the job done.

### Fine Personnel

Perhaps the most important factor contributing to the development of the OWU has been the high quality of the staff that was assembled to do the job. The men who came to Washington to join the ranks of the OWU were far above the average in ability and courage. During the early days in 1941 they endured the most disruptive working conditions. Washington agencies were mushrooming all over the city. Temporary buildings were under construction. Floor space was at an all-time premium. At one time the Power Branch had only 35 sq.ft. per employee. Men had their desks in aisles. Some even worked in their hotel rooms for want of office space. Telephones were difficult to obtain and numbers were changed almost weekly. The offices and aisles were crowded with utility engineers trying to file priority applications in person, applicants for jobs, purchasing agents, Congressmen, manufacturers' representatives, Chambers of Commerce representatives and inventors. The noise was terrific. Men began work at 8 or 9 a.m. and rarely left their desks at noon; they did not quit until 9 p.m. and not infrequently, they

worked on until midnight. This went on six days a week with Sundays frequently thrown in for good measure.

It was under these circumstances of stress that the basic thinking for the whole utilities program was done. In these noisy and crowded offices were developed the original Order P-46 (now U-1), controlling materials for maintenance, repair and construction by electric, gas and water utilities; the original Orders L-50, P-130 and P-132, controlling wire communications utilities; the first power Limitation Order (L-16) providing for the pooling of power resources in the Southeast and the curtailment of power during the dought-created shortage; the power expansion program involving the installation of approximately 7,000,000 kw. of capacity during 1942–1944. The men who came to the OWU in 1941 and 1942 took off their coats and pitched in to do a job. They worked to a point just short of physical and mental exhaustion.

Every effort was made to insure impartiality in administering the war powers delegated to the organization. This quality of impartiality has been extremely important in the administration of priorities. Considering the effect of scheduling production on the affairs of competing manufacturers and of project approvals on the relative position of adjacent utilities, it is obvious that each decision must be made with absolute objectivity and fairness.

## Cooperation Between Federal Agencies

As the OWU developed, effective relations were established between the OWU and the federal and state agencies having an interest in utilities. Because of the complexity and interdependence of the operations of the OWU *vis-a-vis* the Federal Power Commission, written agreements were consummated between the two agencies defining their respective functions and providing for conference and consultation to iron out possible future difficulties. An agreement covering electric power was signed on April 24, 1942, and one covering natural gas on September 11, 1943. Similar arrangements, both formal and informal, have been worked out with other government agencies including the Federal Works Agency, Federal Communications Commission, Departments of State, War, Navy, Interior and Agriculture, the FEA, PAW, SFAW, WFA, ODT, NHA, ORD, Maritime Commission and others.

There remained the task of developing a mechanism for connecting the work of the OWU with the industry itself. This mechanism has been developed and is operating. It includes many different methods of communicating information, ideas, requests and orders. It includes the personal visits of utility officials and manufacturers to the Washington office of OWU; visits and inspections by OWU engineers of projects under construction; group meetings in Washington and in the key cities of each region in the country; and meetings of the 14 OWU Industry Advisory Committees. This has been a fully reciprocal process and the flow of information and ideas has come both from industry to OWU and conversely.

It is also true that industry is conscious that the OWU is a temporary war agency, and not a permanent institution. Accordingly, it is willing to submit to regulations and controls which would be deeply resented if they were to continue beyond the period of crisis. The OWU has made it plain

that it has no desire to regulate industry permanently. Controls are relaxed even during the war just as soon as the need for them disappears.

At this point I should like to express, on behalf of the OWU, our deep appreciation to the water utilities for their good sportsmanship and forebearance in dealing with us. Frequent changes in orders and errors in administration have been unavoidable, but notwithstanding these changes and errors the water works industry has given us its full confidence and support from the beginning.

It is for these reasons that it is meaningless to discuss separately the achievements of the utilities and the OWU. Their efforts have been joint and interdependent. Therefore, in the description that follows of the particulars of the OWU operating programs, it should be understood that the term OWU comprehends not only the staff of the organization itself but all of the instrumentalities of industry as well.

## Office of War Utilities' Operations

The major functions of the OWU may be summarized as follows:

1. Appraising major expansions of utility facilities.
2. Authorizing essential utility construction.
3. Assuring materials for necessary maintenance, repair and operating supplies.
4. Effecting the redistribution of inventories.
5. Planning for allocations in case of shortages of utility services.
6. Scheduling production of equipment.
7. Programming requirements of utilities and manufacturers for critical materials.
8. Co-ordinating conservation of fuel.

### *Appraising Major Expansions of Facilities*

The OWU recognizes as one of its most important responsibilities the guiding of major expansions of utilities' facilities necessary to meet the tremendous war demands and arranging with the industry for the construction of such plant. Such planning and provision of facilities must meet the engineering tests of specifying enough material to do the job without using more material than is necessary for the purpose.

An adequate amount of capacity has been installed so that demands have been met in all sections of the country. At the same time there have been no unnecessary installations, no installations representing an unsound diversion from the remainder of the war program. This result was not accident or good fortune. It resulted from painstaking and remarkably precise estimates of capacities and war loads for each area and the co-operation of the industry in proceeding with the construction and other arrangements necessary to meet the indicated deficits. The precision of the planning was the consequence of a stupendous amount of detailed work and combined consideration to many seemingly unrelated factors. These factors included the new loads to be imposed by extraction of ores and reduction of ores to base metals for the aluminum, magnesium and steel industries; the demands of thousands of new and expanded industrial plants, both large and small, contractors and subcontractors; demands of air and naval bases, cantonments and other military establishments; new requirements for war housing and other new civilian activities; allowances for longer-shift operation of factories; some reduction in non-war civilian

loads; movements in population; reliance on lower margins of reserve capacity than are customary in peacetime operation.

The government took a good deal of responsibility at times in disagreeing with local authorities as to what was needed to safeguard water supply, and just as soon as wartime needs are met, we want to turn that responsibility entirely back to the people to whom it belongs. There is only one reason for a national agency far removed from the location where the problem exists to substitute its judgment for the judgment of the operating people in the community, and that is the scarcity of materials. We are as anxious, as the water works industry is to reverse that situation.

*Authorizing Needed Utility Construction*

Administering a system for authorizing and assigning priorities assistance to utility construction is a challenging and tremendously difficult task, not only because of the physical volume of the detailed work involved, but also because of the dual and sometimes conflicting responsibilities of permitting all utility construction essential to the prosecution of the war and of diverting the largest possible quantity of materials to direct war purposes.

At the start there were no rules. The only guide was the fundamental purpose of the process—to make materials available for national defense. The OWU early developed some general principles to guide the staff in processing applications. The most important of these are the test of essentiality, the rule against duplication of facilities, and the rule that service should be furnished by the facilities which require the least use of critical materials.

No new production facilities are approved unless there is clear evidence that they are needed to avert a shortage. Wherever a new load can be served by either one of two utilities, the utility which can render service with the lesser use of critical materials is preferred. If a utility seeks to build a line which would result in unnecessary duplication of the facilities of another utility, it is denied authorization and priorities assistance.

When the course of the war permits, these restrictions will be promptly relaxed in order to permit a return to the normal practice of consumers' choice. At the present crucial stage of the war, there is no justification for relaxation.

Conflicts between applications filed by competing systems will be resolved by the WPB in the future as they have been in the past; that is, the applicant who requires the least materials to render service will be given the necessary WPB approval. This rule has always been subject to exceptions in appropriate cases, and in those rare instances where an exception is justified, it will be made. However, utilities must continue to operate on the assumption that, in the absence of the most exceptional circumstances, the system that can render service with the least materials is the only system which can secure WPB approval for an extension.

This policy sometimes causes real headaches for the OWU staff but it has paid big dividends in conserving resources for the war.

At the very outset it was evident that if construction jobs of minor size were required to be submitted for authorization in the same manner as major projects, the savings in materials would be more than offset by the burden of paper work on both the utili-

ties and the OWU. Accordingly, utilities are given authorization, under the "U" Order applicable, for small plant additions providing certain conditions of essentiality and conservation are met.

It was also recognized in 1941 and early 1942, that requests for utility service by new customers under wartime conditions would reach record proportions and that many of these requests would not be of an essentiality to the war which would justify the use of critical materials at the expense of war demands or the endangering of service to existing customers where the capacity of existing facilities was almost reached. Accordingly, rules were adopted by the OWU defining the conditions under which new customers may be connected and requiring application to OWU for waiver of the rules where the customer or the utility feels an exception is merited. These provisions, contained in Utilities Orders U-1, U-2 and U-6, are well known to the industries. The policy of the OWU is to make the administration of these restrictions as simple as possible and accordingly the conditions prescribed are changed as frequently as the situation as to critical materials makes such changes advisable.

The magnitude of the task of processing applications is indicated by the fact that for 1943, total correspondence amounted to 582,000 items, representing 140,000 priority applications, 82,000 appeals from limitation orders, and 360,000 letters.

### *Assuring Materials for Necessary Maintenance, Repair and Operating Supplies*

The job of assuring a prompt flow of materials and equipment to utilities for maintenance, repair and operating supplies has been accomplished through Utilities Orders U-1, U-3 and U-4. These orders, and their predecessors, cover electric, steam heating, gas, water, telephone, and telegraph utilities. The orders have gone through a long (and at times tortuous) evolution, but the basic purposes have remained the same. These were to provide a top priority for utilities so that they could secure necessary materials for repairs and maintain the continuity of their essential service, and at the same time restrict the utilities' use of this priority in order to prevent the accumulation of excess inventories.

### *Effecting the Redistribution of Inventories*

Because of the acute shortage of steel, copper and aluminum, and the competing demands for many items of utility equipment in 1942, it was evident that a serious attempt should be made to establish a practical working minimum inventory for utilities, define as excess that part of the total inventory which exceeded the limits of the practical working minimum and effectuate the redistribution of the excess. The mechanics for accomplishing this end differed somewhat between electric, gas, and water utilities on the one hand and telephone and telegraph utilities on the other.

Originally, a catalog was made of copper wire and transformers on hand in the warehouses of the various utilities. Later the National Association of Purchasing Agents developed a plan for promoting the redistribution of excess stocks. In many states the water utilities developed or expanded their mutual aid systems so as to effect a substantial redistribution and conservation of materials. Finally, the OWU,

with the help of the utilities and their purchasing agents, set up an Inventory Control Branch and a field organization consisting of regional utility engineers assigned to the thirteen principal field offices of the WPB. Utilities are required to clear certain purchase orders with the regional utility engineers prior to placing order with suppliers. If the regional utility engineer can locate the desired items in the excess stock of another utility in the same area, the purchasing utility is directed to negotiate with the utility holding the material.

The method followed in the case of telephone and telegraph utilities is for the Communications Division to prepare lists of excess material available in inventory and to distribute these lists widely to the industry to facilitate direct negotiation for the purchase of these items. We are coming pretty close to the end of the need for this program, and in a few months mandatory redistribution of stocks could be eliminated.

By these means, and also by requiring utilities to use up their own excess stocks before placing orders with suppliers, inventories were brought down by about $75,000,000 during the period from June 30, 1942 to December 31, 1943. This reduction represents materials, labor, and shop space in the factories of the equipment producers that were saved through the redistribution activity.

*Planning for Allocations in Case of Shortages of Utility Service*

In the power field there has been no shortage during the war requiring a curtailment of service. However, in early 1942, at a time when war loads were increasing substantially and more rapidly than capacity, the possibility of power shortages had to be anticipated and the Power Branch issued Limitation Order L-94 on May 1, 1942.

The order provided for integrated operation of all interconnected power facilities in each area of the country. In areas where the margin of spare capacity was low, detailed steps were worked out with utilities for dropping certain loads in an emergency in order to maintain voltage and hold the system together. Classes of exempt and non-exempt consumers were listed in the order to guide the utilities in making curtailments should they be necessary.

In the fields of natural and manufactured gas, limitation orders comparable in purpose to L-94 in the power field have been issued. Order U-7 (formerly L-31) is the order applicable to natural gas utilities and Order L-174 to manufactured gas companies. These orders, in addition to prohibiting new space heating installations in areas where supply is tight and requiring the review of new industrial applications, provide for an orderly sequence of curtailment during periods of gas shortage. The curtailment provisions have frequently been applied during periods of winter peak consumption. The orders have assured a continuous supply of gas to the top priority war consumers at the expense of the less essential users of service.

While it has not been necessary to curtail service by water utilities, the OWU has participated in local "save water" campaigns where water supply has been short.

In the telephone industry the efforts to reduce the load on local and long distance facilities have principally been by publicity campaigns conducted by the industry itself.

*Scheduling Production of Equipment*

At the beginning of the emergency the United States was not immediately prepared for the unparalleled Navy and Maritime construction program. Under the guidance of the Navy Department, Maritime Commission and the WPB, American manufacturers of utility type equipment were called upon to produce marine propulsion equipment, boilers, diesel engines and auxiliary facilities for the great shipbuilding program. Initially there was more direct conflict between the utility equipment and the turbines and auxiliaries required by the Navy and Maritime Commission than for any other single class of industrial production. The OWU co-operated with the Navy and Maritime Commission by releasing the facilities of manufacturers to the maximum possible extent.

The OWU had to adopt a "tough" attitude in reviewing its own utility expansion program. Every project was reviewed from the standpoint of its necessity and relative urgency, and approval was given only where the facts disclosed the existence of a critical situation.

A battleship of the New Jersey class requires approximately 200,000 hp. of turbine capacity for all purposes—enough power to take care of five cities the size of Albany, N.Y. At the present time the capacity of the main propulsion units of all types for the Navy is approximately equal to the total installed generating capacity in all power plants in the United States.

Early in 1942 the OWU developed turbine scheduling Order M-76, which was the first order scheduling regulation to be issued by the WPB. Subsequently, scheduling orders L-117, M-293, etc., were issued covering all types of heavy utility equipment, including boilers, condensers, switchgear and related electrical equipment. These orders provided four important advantages:

(1) The schedule of the manufacturers was fixed or frozen for production so that the manufacturer could plan his work well in advance and output could be maximized.

(2) Prior to freezing manufacturers' schedules, a careful study was made of the relative urgency of all orders placed with the manufacturer, individual consideration being given to each order.

(3) The OWU, in co-operation with the military and non-military claimants, achieved a spreading out of the backlog on the books of the various manufacturers so the backlog on all manufacturers in the same industry was evened out to some extent, preventing one manufacturer from having a backlog of 12 or 15 mo. and another a backlog of only 1 or 2 mo. (That tended to increase total output in the country far beyond what it would have been had there been no intervention in that field. It also helped to force a certain amount of subcontracting where it was necessary.)

(4) This method provided almost absolute control of production, being particularly suitable for meeting the emergencies.

Scheduling of production was particularly important because of uncertainty with respect to long-term requirements of most claimants. For example, in the spring of 1942, no one knew precisely how much steam would be required for the synthetic rubber program or how many mechanical-drive turbines would be required by the aviation gasoline program. Since turbines and boilers were such a controlling item

in the successful completion of the synthetic rubber and high octane programs, it was particularly important that estimates be made of requirements so that capacity could be reserved in manufacturing plants for fabrication of the necessary components. Hydroturbines interfered with extrusion presses for aluminum. Oil circuit breakers and switching equipment interfered with switchgear for ship use. Radio and radar transformers interfered with distribution transformer production, etc.

The scheduling job from the very start has meant working in intimate relationship with the Office of Lend Lease Administration in the development of technical studies and programs for equipment delivered to China, Russia and the other United Nations, and with Treasury Procurement in following these projects, through to completion. This equipment includes power plants of all types, industrial boilers, truck-mounted diesels, power trains, and many other items of utility equipment.

The problem of scheduling and production control is not at an end. Consideration is now being given to determining sources of supply for utility equipment that will be needed in relief and rehabilitation of re-occupied countries in Western Europe.

All of you who know the vital and essential character of water service for the needs of the community might speculate on the situation in some of the larger communities, particularly those in the 50,000 or 100,000 population bracket, in the event that the enemy follows a "scorched earth" policy in retiring from Holland, Belgium and France. It will be part of our job, as well as that of the Canadians and the people of the United Kingdom, to see that the right type of equipment is available, is shipped, warehoused, delivered and installed in order to prevent the most complete disruption of economic life and the most complete menace to health that the world has ever seen. That job is beginning now and it will probably rank very high in importance.

*Programming Requirements of Utilities and Manufacturers for Critical Materials*

Part of the job of the WPB is to interrelate all of the war programs within the limits of our materials capacity. This job is carried out within the WPB by the program vice-chairman, who is also chairman of the Requirements Committee. The OWU is established as a claimant agency and as such has membership on the Requirements Committee. Other members are the Army, Navy, Maritime Commission and the major non-military claimants. Each of the claimants presents claims for its programs stated in terms of tonnages of steel, aluminum, copper and other materials. Lumber will soon be added to this list. The national supply of these critical materials is compared with the total of the several claims, and downward adjustments are made in the programs to bring supply and requirements into balance. This is the essential part of the planning mechanism known as the Controlled Materials Plan. The information on military and indirect military programs is brought to a final synthesis at the Requirements Committee. It is through this mechanism that knowledge is obtained concerning *which* resources are really critical, *which* areas require additions to capacity, and *which* programs must be cut if supplies are short. The application to the field of

utilities of program changes brought about ultimately by changes in the strategy of the war is the fundamental part of the job.

*Co-ordinating Conservation of Fuel*

During 1942, the severe shortage of fuel oil on the East Coast made it necessary for practically all electric utilities to convert their generating plants from fuel oil to coal. This was carried out by the industry on a voluntary basis and represented one of the outstanding conservation programs. Similarly, during the last year the utilities on the West Coast have rearranged their operations to use hydro power and natural gas, thereby saving fuel oil which is urgently needed for naval operations in the Pacific.

The country is now confronted with a very tight situation in anthracite and bituminous coal. War requirements for coal have continued to increase while production has not kept pace with requirements. There have been many labor difficulties in the mines and, apart from these, thousands of coal miners have been drafted for military service. Because of the threatened coal shortage, the utilities, particularly electric and manufactured gas utilities, sponsored a national conservation campaign in the fall of 1943. From present indications it appears that there will be a grave coal shortage during the winter of 1944–1945 unless present requirements can be reduced and production increased. If such a coal shortage develops the utilities will join in an intensified drive for fuel conservation. The OWU is working closely with the Solid Fuels Administration for War and with the utilities for the purpose of co-ordinating such conservation. Further to this end, the OWU has been active in recommending to Congress the retention of war time. It is estimated that war time has reduced peak loads in the country by 1,500,000 kw. and has saved about 1,500,000,000 kwhr. annually, which is equivalent to a saving in coal of 1,000,000 tons per year.

## Reconverting Utilities From Wartime to Peacetime Operations

The problems of reconversion are today occupying a central place in the plans of executives in industry and government. The achievement of production goals for the final quarter of 1943 and during the first 6 mo. of 1944 has eased the supply situation in the case of many basic raw materials. For example, aluminum is no longer in short supply. Except for flat-rolled products, supply and requirements of steel are in balance. In the broad field of industrial products there is only a handful of critical components today as compared with hundreds a year ago. The materials shortages that still exist are localized rather than generalized. Serious manpower shortages exist only for certain classes of labor and in certain industrial areas of the country. With a further improvement in the strategic situation it is to be expected that the total military procurement program will be cut back, contracts will be terminated and materials, facilities and men will be released from direct war work.

This change-over from war to peace work must be accomplished with the greatest care, since on the one hand a sudden uncontrolled reconversion would jeopardize the fulfillment of continuing military schedules and, on the other hand, prolonged hesitation and delay would result in unemployment and in waste of manpower resources and industrial facilities.

In the general industrial field reconversion is complicated by the necessity for taking into account many diverse issues of public policy.

There is the question of competition between small and large enterprises, prime and subcontractors, old and new businesses, privately-owned and government-owned plants, etc. There is the further question of selecting the particular plants which will be permitted to convert as against those which will continue to produce war material.

## Priority Control in Peacetime

For the utilities, many of the foregoing problems either do not exist or will prove to be comparatively simple. The basic production or generating plant used to serve war loads is the same as to serve peace loads. Some arrangement of transmission and distribution plant will, of course, be necessary. Generally speaking, utility service can be reconverted overnight to a peacetime basis. The OWU plans to remove restrictions on the use of material—restrictions on design, construction, inventories, etc.—just as soon as such relaxation can be put into effect.

That is not tomorrow and it is not going to be done merely because the beachhead which has been established is good firm beachhead, but it will be done just as soon as there is obvious evidence that the restrictions are not necessary.

For large construction projects it will probably be desirable to continue priorities control, at least during a period of 6 mo. or a year during which time the sequence for completion of large projects should be determined in terms of relative urgency.

The reason for that is that during the war some very worthwhile projects were deferred. There are many specific cases, the denial of which resulted in severe financial hardship and in high operating costs. Those applicants who are holders of revoked or suspended projects should be given very special consideration.

On the other hand, if all control over large projects were rescinded overnight, it is possible that orders would pick up and jam and nobody would get anything. It would be a situation analogous to the one in the fall of 1941 and the first 6 mo. of 1942 when the order boards were so crowded that the deliveries fell behind.

The manufacturers of utility type equipment are in a position which lends itself to rapid and uncomplicated reconversion. Many of these manufacturers have been making the same or substantially similar items of equipment for the armed forces during the war as they made for the utilities before the war. Machine tools and skilled labor can again be devoted to peacetime uses with a minimum of change-over difficulties. There will be few new machine tools required and very little new employee training. As a matter of fact, during the period just ahead it may be desirable to permit partial resumption of production of utility equipment in these plants while they continue to be engaged in filling direct war orders. The value of such partial resumption is that it will maintain intact the nucleus of the organization to be available to meet any future military production crisis which we cannot now clearly anticipate but for which we must be prepared.

In considering approval of large utility projects the OWU will continue to assess their essentiality and urgency as well as their impact on manufacturers' facilities. If the equipment for such projects can be produced

without substantial conflict with war orders, approvals will be granted. Here the question of conflict will have to be studied, not only from the standpoint of use of facilities, but also from the standpoint of the use of men within the manufacturing plant itself and within the labor area in which the manufacturing plant is located. The present projection of Army, Navy and Maritime Commission programs indicates the possibility of a rather substantial resumption of utility equipment manufacture during the next 12 mo.

## Conclusions

The important fact is that no war plant has ever been held up because of lack of service. Utility systems have provided all of the facilities needed by every factory and by every military and naval establishment. At the same time, they have carried their regular civilian loads. To do this, it has been necessary to increase installed capacity and to operate both old and new capacity at abnormally high-load factors and for unusually long hours.

The author believes everybody in Washington realizes the difficulties that the utilities have had in maintaining their labor force. With Selective Service losses and withdrawals into other industries, there has been a great shrinkage of personnel. One of the great outstanding managerial achievements has been that the utilities have been able to do their construction and maintain their service in spite of real handicaps on the manpower front.

Through improved design and engineering practice, through wide interconnection and co-ordination of facilities, through unique resourcefulness in overcoming the countless handicaps which war conditions impose, the utility systems have made good their pledge that service would never be too little or too late. By economizing to the limit in the use of materials, equipment, manpower and fuel, the job has been done without interference with the urgent military programs which depend for their execution on the same scarce resources. The employees and the managers of the country's utility systems deserve the highest esteem of the nation for this remarkable performance.

# Program and Policies of Water Division
# Office of War Utilities

*By Arthur E. Gorman*

IN his address two years ago, at the Chicago meeting of the American Water Works Association, Edward Falck's predecessor, J. A. Krug, placed squarely before water utility operators of the nation the problems which had to be faced in support of the war. He requested co-operation in reducing water utility inventories so that critical material urgently needed for the war construction program might be made available from excess stocks. He also announced the decision to organize a water section in the Power Branch in order that the pressing problems involving both the water utility and the War Production Board might be solved on a basis of mutual understanding and co-operation. During the two years which have passed since that meeting, world events of profound importance have occurred, reaching crescendos in war production and military actions almost beyond belief.

This paper is a discussion of some of our common and immediate problems and responsibilities, pending the indicated outcome of the campaign for liberation of Europe just begun; a comparison of the current availability and use of materials and manpower with that of former years; and a report of some of the methods and results of our co-operative effort since the Water Division was organized to represent and serve the water utility industry within the WPB.

## The Current Situation

For the present, and until favorable military decisions dictate otherwise, it is the plain duty of every water utility to "hold the line" that manpower and materials may be diverted quickly and effectively into whatever channels are necessary to meet military contingencies. This does not mean that plant maintenance should be deferred or that *must* projects should be stopped. Support of the war effort at this critical stage makes it imperative that such work go on, and materials will be made available to water utilities for these projects. But, obviously, deferable and non-essential projects should be held up and long-term projects should not be pressed until more stable conditions as to materials and manpower are assured. While we wait, however, we can plan, and if we plan well, we shall be better able to meet wartime contingencies and to adapt our programs to the changes in conditions which are sure to follow in the wake of war. Never before has the responsibility of water utilities been heavier, never before has the backlog of de-

An address presented on June 15, 1944, at the Milwaukee Conference by Arthur E. Gorman, Director, Water Division, Office of War Utilities, War Production Board, Washington, D.C.

ferred utility construction and maintenance been greater, and never before has organizing ability and ingenuity been at a higher premium.

So long as our economic system is dislocated by war, and later, in the trying transition period when war requirements give way to reconstruction needs, obtaining materials for water utility construction programs is likely to offer some real problems. The Water Divisions recognizes your patience with and concern over continued restrictions which affect utility operations. As materials become available with improvements in the military and production programs, the division will be alert to recommend such actions as are consistent with the over-all policies which must govern relationships between war and civilian economy.

**Availability of Materials**

Since Pearl Harbor the availability of materials for water utility needs has gone through some interesting changes. During the war construction period, cast-iron and cement-asbestos pipe, as well as valves, hydrants and other essential items for water distribution systems, were extremely critical. Normal standards for water system extensions had to be crimped. Today, these items are available for essential projects, and departures from good water works practice in their use are no longer necessary. The general shortage of reinforcing steel, and in some areas cement, which existed early in the war and even a year ago, made it necessary to defer construction on many important water works projects. While these materials are available today, construction of this type is, unfortunately, handicapped because of shortages of form lumber and manpower. Utilities which must go forward with the construction of reinforced concrete structures should reckon with a continued shortage of form lumber and plan on the use of available forms and used or substitute material. This tight situation is likely to continue until the war is over because of the great need of lumber for packing war exports. (Oddly enough, two years ago, it was necessary to use lumber as a substitute for steel; and reinforced structures requiring large amounts of form lumber were being substituted for steel-framed structures. *Today, structural steel, which has been available, is again becoming a tight item.*)

Steel plate and sheet are still critical because of the great demand by direct war production, especially for ships and landing barges. Therefore, requests for large-size steel pipe and elevated tanks should, if possible, be deferred. Prior to 1944, no steel was authorized for elevated tanks for water utilities. This was because it was more desirable from the standpoint of critical materials to use reinforced concrete ground storage with repumping than the plate steel. The importance and economic advantages of elevated storage are well recognized. It is estimated that a pent-up demand for approximately 100,000 tons of steel for tanks now exists in water utility systems. This year, because form lumber for ground tanks is not available, steel tank construction involving 3,000 tons has been authorized, but mostly for late deliveries extending into the first quarter of 1945.

In general, instruments and control equipment, especially those requiring fractional horsepower motors, are still critical. Components such as antifriction bearings, carburetors and electrical recording and indicating meters are in demand for a variety of programs.

The supply of copper and copper alloys is about in balance, with demand under current military requirements, but their availability will continue to depend on changing military requirements. The need of more water meters and the increased production which could be effected by permitting manufacturers to make standard all-bronze meters in lieu of the iron-body wartime meter has caused the division to take a strong stand in recommending an amendment to Schedule I of Order L-154 and in recommending the allocation of the necessary secondary metal to make the all-bronze meter.

*It is my pleasure at this time to announce that effective today (June 15, 1944) this order has been amended to permit the manufacture of all-bronze meters after July 1, 1944. The allocation of secondary metal is only enough to permit the same number of all-bronze meters to be made as have been manufactured using the iron body. This situation will, we hope, improve, but until that time, it is important that orders for all-bronze meters up to the limit of this allocation be for the more important projects where metering is essential for conservation purposes. The co-operation of the utilities in limiting meter purchase to essential needs will help in this period of transition and will, I am sure, be appreciated by the manufacturer. The Water Division will ask the A.W.W.A. Wartime Activities Committee to co-operate with it in making recommendations for equitable procedures of distribution of meters to water utility systems.*

As to copper tubing for service connections, the amendment to Order M-9-c-4 in January [1] released tubing frozen since October 1942 in utility inventories. It goes without saying that this tubing should be used wisely. (An especially good use is in installations where manpower can be saved, as under paved streets.) The desire of water utilities to have production of copper tubing increased and to purchase from warehouse stocks is understandable; and as soon as the military situation indicates that relaxations in copper can be made, a further amendment to the limitation order to provide for additional production and more liberal distribution of this important material will be urged.

As for pumping and power plant equipment, while war related demands are heavy, these items can be obtained for essential projects. Pumps in the more common water utility sizes, and including deep well pumps, are generally available. Some manufacturers have more non-war fabricating capacity than others, and where early delivery is a factor, it is important that this situation be taken into account in placing orders. The availability of electric motors from 1 to 100 hp. and heavy-duty gas engines has improved. Large motors and diesel engines are still tight and more critical than pumps. Because of available manufacturing capacity, boilers are easier than they were a year ago. However, as steel plate is still critical, only boilers to meet essential needs can be approved at this time.

Generally, equipment of large capacity is under schedule, and its delivery may be slow. Applications for essential equipment of this kind should be filed with the Water Division well in advance of expected construction so that we may co-operate in scheduling of production and follow through to co-ordinate delivery with the progress of field work.

The division accepts as one of its obligations to utility applicants to whom

[1] Jour. A.W.W.A. 36: 255 (1944).

it has given priority ratings the responsibility of following their projects through until material and equipment needs are met. This work requires the co-operation of production officials of industry and scheduling staffs of various WPB industry divisions, but it has proven well worth while as a means of assuring adequate water supply at the right time and place. In emergencies, when requesting special assistance to obtain extremely critical materials or special priority ratings to effect earlier delivery of approved materials, it is important that the applicant furnish with his request all information concerning the rating required. This should include accurate description of material, name of supplier, date and number of order placed with the manufacturer, and, of prime importance, an explanation of the basic cause and urgency of need, giving specific facts to justify the request for special materials or out-of-line ratings.

To our knowledge no essential water utility system is being seriously embarrassed in its operations under the current limitations on materials. If there are any, the Water Division desires to help in any way that it can.

## Simplification of Procedures

The Office of War Utilities is continuing its efforts to simplify and reduce paper work required of utilities in procedures necessary to obtain material for new construction. The new WPB-2774[2] which went into effect June 1, together with Direction 4 of CMP Regulation 6, is the most recent step in this direction. The new procedure simplifies the listing of materials to permit lumping of smaller items by cost. If the total requirements do not exceed 50 tons, carbon steel need not be listed by quarters. Allotment number U-2 is to be used in placing orders for controlled material where allotments in specific quantities are not made for specific quarters. An approved WPB-2774 application includes authority to begin construction of buildings for utility purposes in cases where specific approval is required by Order L-41.

The U-1 Order, governing supply of material for maintenance, repair and operation of water utilities, appears to be reasonably well understood by operators. Many, however, are not taking advantage of its liberal automatic priorities given specifically to permit a high order of maintenance of plant. This may, in part, be due to a shortage of manpower, but neglect of scheduled maintenance ultimately will be costly in materials, manpower and money.

## Manpower

Recently, Selective Service policies and regulations have been greatly clarified and it now appears that necessary water utility employees in the 26–29 age group and practically all employees 30 yr. of age and over have a firm basis for deferment.[3] Utility management should, nevertheless, be alert to the possible effects of new policies on its operations and plan accordingly. The use of women in water works operation has more possibilities than is generally realized, and the pooling of manpower by utilities has much to commend it.

In April 1944, the Water Division conducted a nationwide index survey (by questionnaire) of the age, sex and occupational distribution of water utility employees in order to obtain a basis for estimating how future Selective Service policies and procedures

[2] *See* p. 860 this JOURNAL.

[3] Jour. A.W.W.A. **36**: 690 (1944).

might affect the water industry. Returns indicated that of the 62,200 remaining water utility employees in the United States serving about 87,000,000 people, 22,300 or 36 per cent were classified as occupying critical positions.[4] Of these critical employees, 1,012, or 4.5 per cent, were women; 17,280, or 77.5 per cent, were men over 38 or 4F's; and 4,008, or 18 per cent, were men under 38 and hence draft vulnerable.

The distribution of the draft vulnerables by age groups were:

*Age Distribution of Draft-Vulnerable Critical Water Utility Employees*

| *Age Group* | *Number* | *Percentage of Total* |
|---|---|---|
| Under 26 | 204 | 5 |
| 26–27 | 119 | 3 |
| 28–30 | 673 | 17 |
| 31–37 | 3,012 | 75 |
| Total | 4,008 | 100 |

About 35 per cent of the draft vulnerables were classified as operating engineers. Meter repairmen, foremen and skilled laborers were the next most important groups.

In considering priority assistance for construction projects, the availability of manpower, as well as materials, must be considered. In areas where an acute shortage of labor for war production exists, projects calling for the employment of more than 25 men over those currently on the payroll of the utility must be cleared through a special urgency committee in WPB regional offices before the WPB-2774 priority can be issued by the Water Division.

At present, these urgency areas include the Pacific Coast; central and southern Connecticut (including Hartford, New Haven and Bridgeport); and the metropolitan districts of Chicago, Cleveland, Akron, Buffalo and Niagara Falls.

## Rainfall and Conservation

It is encouraging to be able to report that the grave concern early in February of this year as to adequacy of rain and snowfall to replenish surface and underground storage has been removed due to the adequate precipitation of March and April. It now appears that, with certain regional exceptions, for the fourth successive year our nation's water supply sources are not likely to be jeopardized by the threat of deficiencies in rainfall. Currently, there are, however, limited areas in Montana, eastern Oregon and Washington, Arizona and New Mexico, Upper New England and New York State, and southern Florida where lack of rainfall could cause embarrassment to water utilities this summer.

Throughout the country the need of continued pressure for consumer cooperation in conservation of water is essential to maintain service without the need of additional facilities to meet excessive demands, to conserve our stored supply as a hedge against future deficiencies in rainfall and also to save fuel, which is likely to be a most critical item next winter. Utilities using solid fuels are advised to be prepared in case limitations of supply this winter should become necessary. If supply difficulties arise, operators should notify the Water Division which will act promptly to assist.

## Water Division Organization and Policies

At this time it may be of interest and of value to review briefly some of the policies which have guided the

[4] [This represents a reduction of approximately 20 per cent from the 1940 total employed in water works systems in the U.S. *Editor.*]

Water Division and some of the results of its operations. Water as a separate utility was officially represented in the WPB organization when a Water Supply Section was created in the Power Branch in August 1942. In March 1943, when the OWU was organized, the Water Division was created as an integral operating unit, along with similar divisions representing the power, gas and communications utilities.

Each WPB industry division is responsible for direct war production or service in support of war production by the industry it represents. The Water Division has endeavored to meet this responsibility and its counterpart of conserving critical war materials through an understanding of the problems of the utility and co-operation with its operating officials. Through the organization of six regions, with an experienced water works engineer in charge of each, it has been possible to decentralize work and to bring the division into closer contact with utility operators and their problems. In general the size of these regions takes into account the density of water utility plants and the extent of war impact on them.

While the Water Division, which now consists of 37 employees, including 28 experienced water works engineers, is a relatively small WPB division, its contacts during the last two years have been active with thousands of water utility systems in this country and its territories and several foreign countries. They have even included a detailed study of facilities which might be needed to restore water service on the continent as occupied areas are liberated.

Problems of wide variety and different degrees of urgency and importance had to be resolved. This required effective co-operation with utility operators and their consumers, water works equipment manufacturers, designers and operators of a wide variety of war production plants and many state and federal agencies. Besides acting as a claimant agency for utilities, the OWU, through its Water Division, sees that war industry obtains its water needs with a minimum use of critical materials. Applications for water supply facilities by the WPB industry division and other claimant agencies are referred to the Water Division for review and technical assistance. During the last 8 mo., nearly 200 applications were referred to the Water Division by such war agencies as the Chemicals Bureau, Petroleum Administration for War, War Foods Administration, Office of Rubber Director, Army Air Forces, Army Service Forces and others. About 9 per cent of these applications were modified on the basis of recommendation made by the division.

### Co-operation With Other Agencies

As a unit in a temporary war agency, the Water Division has endeavored to do its war job without duplication of effort, and it has followed the policy of making full use of existing federal, state and local agencies. The division is particularly indebted to the U.S. Geological Survey, the U.S. Public Health Service, the Federal Works Agency, and Engineering Divisions of the various state departments of health. The Geological Survey, through its divisions of Ground Water, Surface Water, Water Quality and Water Utilization, has rendered distinguished and effective service to the Water Division and others in the WPB and its predecessor, the Office of Production Management. Without this co-operation, our wide

service to water utilities and industries would not have been possible. Over 1,150 reports on ground and surface water conditions have been submitted to war agencies, 345 of which were made to the Water Division in the last 2 yr.

### Invaluable Assistance

Each month the staff of the division is presented with the U.S. Geological Survey's "Water Resources Review," containing timely and accurate information concerning rainfall, stream flow and snow runoffs, ground water conditions and contents of principal reservoirs throughout the country. When, in the winter of 1942, it seemed likely that it might be necessary to place limitations on the withdrawal of ground water from certain critical areas where lowering of water levels and salt intrusions into fresh aquifers threatened water supply for war production, the division enjoyed the full and active support of the U.S. Geological Survey's staff.

The U.S. Public Health Service has worked very closely with the Water Division. Its Sanitary Engineering Division has rendered consulting service with respect to specific projects; has furnished information from its files concerning capacities, characteristics and requirements of various water utilities; and its field staff, through special surveys, has obtained information needed for prompt and intelligent action on applications for priority assistance on projects. Since July 1943, that Service furnished the division with 219 reports on water works requirements in 213 communities and 37 states and territories.

The FWA, by means of its war construction program authorized by the Lanham Act, has assisted communities in maintaining water service where the impact of war projects placed loads on their systems too heavy to have been met without outside financial aid. To date, 400 water works projects have received federal aid in part or whole under the terms of this act, the total cost of these projects being in excess of $90,000,000. Special projects undertaken by this agency at the request of WPB were the two canals which bring water from the San Jacinto River to war industries in Baytown and the Houston Ship Canal area in Texas; the 20-mi. pipeline project which brings well water from the Big Miami fields south of Hamilton, Ohio, into Mill Creek Valley to serve the Wright Aeronautical plant, and the Detroit Booster Pumping Station which now assures adequate water supply to war industries north of the city limits.

### Interests Integrated

There are no less than thirteen federal agencies having a prime interest in firm and safe water supplies under war conditions. The Water Division has taken the initiative in integrating these diversified interests and obtaining a weighted appraisal of the importance to the war effort of 1,800 water utility systems supplying water more or less directly to one or more war plant or agency. From this, 551 were agreed on as key systems meriting special consideration as to facility requirements to maintain firm service. They represent less than 4 per cent of the water utility systems in this country, but serve 46,000,000 consumers, or about 53 per cent of those supplied from all systems.

Utilities have been classified on the master responsibility list as to their over-all importance to the nation's war effort. Currently, these ratings are distributed as follows:

| System Classification | Number Utilities |
|---|---|
| A | 5 |
| B | 8 |
| C | 187 |
| D | 106 |
| E | 245 |
| Total | 551 |

The division has worked closely with the Security and Utilities Officers of the Army and Navy and has enjoyed the active co-operation of various boards of fire underwriters, state and local health and utilities commissions.

Last, but not least, it has received the fullest co-operation from the A.W.W.A. and all its sections, the Water and Sewage Works Manufacturers Association, as well as that of similar regional, state and local utility associations such as the New England Water Works Association and the Maine Utilities Association.

### Some Comparisons of Utility Operations

At this period, which marks the fullest fruition of our joint co-operative program, water utility operators might be interested in an appraisal of our current actions and comparison with those of previous years.

### Inventories

When J. A. Krug addressed the A.W.W.A. convention in 1942, he showed that, in spite of the urgent need of materials for the war construction program, water utilities had increased their inventories since December 1940 over 18 per cent—probably an all-time high. He announced an amendment to the P-46 Order which was to be promulgated, reducing utility inventories and making stocks in excess legally available for redistribution under a priority system for war construction. The water utilities supported this order loyally and a material crisis was met. The pre-Pearl Harbor inventories of December 1940 of 282 large water utilities, now serving 58,000,000 of 85,000,000 consumers, totalled $18,787,000, excluding fuel. In June 1942 they were $22,125,000. As of today they are estimated to be $18,500,000, or just under the pre-Pearl Harbor figure.

### Steel Authorized

Steel is the most important controlled material used by the water utility. During the first quarter of 1943, steel authorized for new construction totalled 3,235 tons; that for the first quarter of 1944 was 9,196 tons—an increase of 186 per cent. In the former quarter, slightly over one-half of this steel was obtained from excess inventory stocks; in the latter quarter, less than one-third was from this source, the remaining 6,300 tons being purchased from manufacturers.

The percentage distribution of the steel used for water utility construction during the first three quarters of 1943 was:

| | |
|---|---|
| Reinforcing | 50 |
| Pipe | 16 |
| Plate | 14 |
| Structural | 5 |
| Miscellaneous | 15 |
| Total | 100 |

### Project Applications

Since January 1944, water utilities have filed an average of 375 WPB-2774 project applications per month. The total cost of these projects averaged $10,000,000 per month and the material cost $6,000,000. During July and August 1943, just before Supplemental Order U-1-f [5] went into effect, allowing utilities to make minor extensions up to $1,500 without filing applications

[5] Jour. A.W.W.A. **35**: 1241, 1383 (1943); **36**: 119 (1944).

for priorities, the division received from utilities an average of 1,450 applications per month. These projects represented an average total monthly cost of $5,000,000 and $2,000,000 for materials. In less than a year applications received have decreased 76 per cent, while the average cost of projects and materials approved have increased 100 and 200 per cent, respectively.

### Types of Projects

The following table shows the classification by types of 3,134 project applications received from water utilities by the division for the 8-mo. period, October 1943 through May 1944:

| *Type of Project* | *Number Applications* | *Total Cost* | *Percentage of Total* |
|---|---|---|---|
| Treatment... | 447 | $17,800,000 | 24.6 |
| Transmission and Distribution.... | 1,795 | 23,800,000 | 32.8 |
| Supply...... | 527 | 22,200,000 | 30.7 |
| Pumping.... | 365 | 8,600,000 | 11.9 |
| Total..... | 3,134 | $72,400,000 | 100.0 |

Of special interest is a comparison of the cost of 1,580 water utility projects received from January through May 1944 from the various regions giving consideration to population and the war impact as shown in the following table:

*Utility Applications Received January Through May 1944*

| *Water Division Region* | *Number* | *Per Million Pop.** | *Total Cost of Projects Per Million Pop.** |
|---|---|---|---|
| 1 | 116 | 6 | $ 65,000 |
| 2 | 227 | 14 | 670,000 |
| 3 | 187 | 35 | 680,000 |
| 4 | 278 | 14 | 640,000 |
| 5 | 255 | 21 | 940,000 |
| 6 | 617 | 64 | 1,115,000 |
| Average for all regions | | | $610,000 |

* Population supplied water from utility systems.

These data show that in Region No. 1, comprising New York State and the New England states, the value of projects per million population was only one-tenth that of the national average, although that region ranks second in magnitude of war contracts. The cost of projects in Region 5, the western and south central states from Canada to Mexico and including Texas, was 50 per cent over the national average, although it ranks fifth in value of war contracts. Region 6, with a large percentage of its projects on the West Coast, had a cost per million population nearly twice the national average and seventeen times that for Region No. 1. The project cost rate for the other three regions was quite uniform, but slightly in excess of the national average.

These data indicate the relatively firm situation as to water facilities which existed in Region No. 1 and the serious load which the war impact placed on water systems in Regions 5 and 6. The nature of the new war industries in Regions 5 and 6 was such that they required the use of large amounts of water.

### Pacific Coast Problems Serious

Some of our most serious water problems still exist on the Pacific Coast and in the Southwest, especially in California, Texas and Oklahoma. The water supply situation in California could have been a serious drawback to our war production program had rainfall not been favorable in the years preceding Pearl Harbor and since. As the Pacific Coast is destined to play a strategic part in the military actions against Japan, we must make available to their utility systems materials which are necessary to support their war services and be prepared for the con-

tingencies which will surely arise if rainfall deficiencies occur between now and the end of the war.

## Summary

The following is a summary of the current situation as to Water Division policies and procedures as they affect water utilities and others:

1. In order that all channels of manpower and materials may be held open to support accelerating military programs, water utilities should limit construction to essential *must* projects until the outcome of major campaigns under way this summer are indicated.

2. Maintenance and repair of utility plant should be kept at a high level; and materials will be made available for this work.

3. Planning of projects *now* will place utilities in a better position to take advantage of early relaxations in the material situation when war production demands taper off; and also to co-operate with federal agencies responsible for adjustments in the transition period from wartime to peacetime economy.

4. The situation as to availability of materials for water utility construction has improved markedly in the last year, but there are still many tight items, especially form lumber and steel plate and sheet, which will limit certain types of construction.

5. Although water utilities have lost many employees to the Armed Forces and to war production plants, their operations have not been seriously impaired, but minimum safe operating levels have been reached. Loss of employees under 26 yr. must be reckoned with. This group represents only 5 per cent of the employees classified by the water utilities as critical. Seventy-five per cent of the critical employees are over 37 yr. of age.

6. Water utility projects approved in 1944 to date averaged $10,000,000 total cost per month—twice the rate of a year ago. The cost of materials in these projects was about three times that of a year ago.

7. On the basis of population served by water utilities, there is a wide variation between regions in the rate of expenditures for war water works construction. The greater rates of expenditure are for Pacific Coast and Southwest projects, where the impact of war on utility systems has been heavy. In general, New England and New York water systems appear to have been affected least by the demands of war programs.

8. The Water Division has endeavored to carry out its programs and policies on a co-operative basis with utilities, industry and federal, state and local agencies. It has enjoyed the support and confidence of all.

# Revision of Form WPB-2774

AS of June 1, 1944, the procedure to be followed by utilities in applying for authority to do construction work beyond the scope of order U-1, was revised.*

Simultaneously CMP Regulation 6, Direction 4, was set up to authorize the use of the allotment number "U-2" to obtain controlled materials.

Form WPB-2774 has been revised and the routine related to it adjusted to meet the new conditions. The letter of transmittal follows:

The new procedure is designed to improve existing practices in the following ways:

1. It simplifies the listing of materials and equipment in Section III.

2. It makes unnecessary listing of controlled materials requirements for most applications.

3. It eliminates the necessity for item-by-item materials accounting in most cases.

4. It will reduce the frequency of amendments.

The new procedure in general outline is as follows:

A. *Application Procedure*

1. Utilities must describe in Sections I and II of the Form WPB-2774 the construction or other action proposed.

2. Materials and equipment required must be listed in Section III. It is no longer necessary, however, to make a separate listing of "material for which rating or allotment is requested." More specific instructions are given in Section III on grouping minor items. It is hoped that such grouping will considerably reduce the length of these material lists.

3. Quarterly controlled material requirements must be listed only as follows:

For carbon steel, if requirements exceed 50 tons.

For copper wire and cable, if requirements exceed 5,000 pounds.

For aluminum wire and cable, if requirements exceed 2,500 pounds.

These quantity limits apply to total requirements for the job rather than to requirements for particular quarters.

B. *Authorization Procedure*

1. If approved, the construction, installation, or purchase described in Sections I and II of Form WPB-2774 will be authorized, subject to any restrictions noted in Section V of the form. If the applicant later proposes to deviate from the action described he must file an amendment to obtain specific authorization for the deviations. Thus, an amendment will be required before a line can be built past the terminus mentioned in the application, or its route varied.

2. The applicant will be restricted to the kinds, types, sizes and capacities of materials and equipment which are

* WPBI-1932, May 30, 1944.

listed and approved in Section III of his application. Thus, an applicant who states that he intends to use a given size of aluminum conductor for a construction project may not use copper conductor or a larger size of aluminum conductor without first filing an amendment and obtaining specific authorization for the change.

3. Most applicants on Form WPB-2774 will receive an authorization, preference ratings and an allotment number permitting the use and, if not available from inventory, the purchase of approved materials and equipment items in whatever quantities are required for the purposes stated in the application. In some cases, however, applicants will be limited to the purchase or use of specific quantities of certain items, or other restrictions may be specified. For example:

a. Specific quarterly allotments of one or more controlled materials will be made in approving some applications. This will be indicated by War Production Board entries of quantities in the "allotted" columns of Section IV, columns (d), (f), or (h) and by typing or stamping an additional paragraph in the authorization section. Where such allotments are made, they must not be exceeded.

b. The War Production Board may restrict the use of certain items to the quantities set forth and approved in Section III, by marking "Limited" opposite such items in column (f) of Section III. See Section V, paragraph 7 of Form WPB-2774.

c. The use of certain items will be restricted to amounts available in utility inventories not to be replaced, by marking "Inventory" opposite the item in column (f) of Section III. See Section V, paragraph 8 of Form WPB-2774.

Utilities should use the revised Form WPB-2774 as an application form for utility actions requiring authorization and priorities assistance not provided for in Orders U-1, U-3 and U-4. This includes authority to begin construction of buildings for utility purposes in cases where specific approval is required by Order L-41. Communications utilities, which have been using Form WPB-617 for such applications, should change to use of Form WPB-2774.

Utilities should not use Form WPB-2774 in making applications which do not involve utility operations. For example, Form WPB-2774 should not be used to apply for permission to build an office building for the *principal* use of others than the utility, to make additions to a street railway, etc.

The purpose of Direction 4 to CMP Regulation 6 is to provide an enabling instrument under CMP for the use of the allotment number U-2 in placing orders or contracts where allotments are not made in specific quantities or for specific quarters.

It is believed that the revised form and procedure constitute an important saving of time and manpower for the utilities and for the War Production Board. (*See* pp. 862, 863, 864.)

### *WPB DIRECTION 2 TO U-1*

***Form WPB-2774 authorizations issued since June 10, 1944, contain provisions which permit applicants to obtain and use materials under a simplified procedure (See pp. 862–864 this* JOURNAL*).***

***Utilities Order U-1, Direction 2, issued July 18, 1944, by War Production Board through OWU (WPBI-2157), makes applicable the simplified procedures provided for in the June 1944 revision on application Form WPB-2774 to authorizations issued to producers on Form WPB-2774 before the revised application form came into use.***

FORM **WPB-2774** (6-1-44) UNITED STATES OF AMERICA WAR PRODUCTION BOARD

**BUDGET BUREAU NO. 12-1136.4 APPROVAL EXPIRES NOVEMBER 5, 1944**

## UTILITY APPLICATION FOR AUTHORITY TO BEGIN CONSTRUCTION, PREFERENCE RATINGS, ALLOTMENTS OF CONTROLLED MATERIALS, AND OTHER PURPOSES

5. DATE — FOR WPB USE ONLY — 6. OWU SERIAL NO.

7. APPLICANT'S REFERENCE NO.

TO: War Production Board, Washington 25, D.C.
ATTN: *Office of War Utilities*

NAME AND ADDRESS OF APPLICANT *(Street, City, Zone, State)*

8. IS AN APPLICATION FOR A NECESSITY CERTIFICATE (FORM WPB-3467) BEING FILED WITH THIS FORM? *(See Instructions)* ☐ YES ☐ NO

9. TYPE OF UTILITY
☐ ELECTRIC ☐ WATER
☐ NATURAL GAS ☐ MFD. GAS
☐ STEAM HEATING ☐ COMMUNICATIONS

**INSTRUCTIONS** - Submit *original and two (2) copies* of this form. Only two sets of supporting papers are required. If a Necessity Certificate under Section 124(f) of the Internal Revenue Code is being requested in connection with this application, attach Application for Necessity Certificate *(Form WPB-3467)*, and submit one additional copy of WPB-2774 and supporting data. If WPB-2774 is required to be filed with a builder's application under L-41, transmit to the builder.

APPLICATION STATUS

10. THIS APPLICATION IS: ☐ INITIAL ☐ AMENDMENT ☐ RESUBMISSION

11. IF AMENDMENT OR RESUBMISSION, FURNISH FOR ORIGINAL APPLICATION

| (a) FORM NO. | SERIAL NO. | DATE SUBMITTED |
|---|---|---|
| | | |

(b) SEVEN DIGIT ALLOTMENT NUMBER PREVIOUSLY ASSIGNED, IF ANY

U - 2 ☐ ☐ - ☐ ☐ ☐ ☐

### SECTION I - IDENTIFICATION AND DESCRIPTIVE DATA

1. BRIEF DESCRIPTION AND LOCATION OF CONSTRUCTION OR INSTALLATION, INCLUDING NAME OF CUSTOMER, IF ANY.

12. PROJECT STATUS

| STARTING DATE FOR CONSTRUCTION | DATE SCHEDULED FOR COMPLETION | PERCENT NOW COMPLETED |
|---|---|---|
| | | |

13. ESTIMATED COST

IF AN AMENDMENT, FURNISH ONLY DOLLAR VALUE ADDED BY AMENDMENT

| ITEM (a) | GROSS COST (b) | NET COST[1] (c) |
|---|---|---|
| MATERIAL | | |
| LABOR | | XXXX |
| OTHER COSTS | | XXXX |
| ***TOTAL*** | | XXXX |

[1] *Gross cost less cost of material removed from plant. Not to be filled in by Communications Operators.*

2. ***NOT TO BE FILLED IN BY COMMUNICATIONS UTILITIES***

(a) IF PROPOSAL IS TO SERVE A CUSTOMER, GIVE:
STATUS OF CUSTOMER'S OR BUILDER'S APPLICATION UNDER L-41 FOR PERMISSION TO BEGIN CONSTRUCTION:
☐ CUSTOMER STATES NOT REQUIRED ☐ SUBMITTED WITH THIS FORM ☐ PREVIOUSLY SUBMITTED

IF L-41 APPLICATION WAS PREVIOUSLY SUBMITTED, STATE

| DATE | RETURNED BY WPB ☐ YES ☐ NO | IF RETURNED - WPB SERIAL NO. |
|---|---|---|
| | | |

(b) STATUS OF CUSTOMER'S CONSTRUCTION
☐ NOT STARTED ☐ UNDER CONSTRUCTION ☐ COMPLETED ☐ NO CONSTRUCTION

3. WILL THE CONSTRUCTION OR OPERATION OF THIS PROJECT REQUIRE THAT MORE THAN 25 PEOPLE BE ADDED TO YOUR PAYROLL OR USED BY CONTRACTORS ON THE JOB? ☐ YES ☐ NO

IF YES, STATE TOTAL NUMBER OF PEOPLE TO BE ADDED TO PAYROLL OR USED BY CONTRACTORS. — NUMBER

4. ***TO BE FILLED IN ONLY BY GAS UTILITIES***

IN CONNECTION WITH THIS APPLICATION, IS A CUSTOMER'S APPLICATION TO WPB REQUIRED FOR A SPECIFIC EXEMPTION FROM THE RESTRICTIONS OF ORDER U-7 OR L-174? ☐ YES ☐ NO

14. ***TO BE FILLED IN ONLY BY COMMUNICATIONS UTILITIES***

DOES THIS APPLICATION OR USE OF THE PROPOSED FACILITIES INVOLVE RELIEF FROM THE RESTRICTIONS OF ORDER U-2 OR U-6? ☐ YES ☐ NO

| IF YES, STATE | ORDER | PARAGRAPH |
|---|---|---|
| | | |

**CERTIFICATION** - THE UNDERSIGNED HEREBY CERTIFIES THAT HE IS THE APPLICANT OR THAT HE IS AUTHORIZED TO EXECUTE THIS APPLICATION ON BEHALF OF THE APPLICANT; THAT THE QUANTITIES SPECIFIED ARE NOT GREATER NOR THE REQUIRED DELIVERY DATE(S) EARLIER THAN NECESSARY FOR COMPLETION ON TIME OF THIS CONSTRUCTION; AND THAT THE FACTS HEREIN SET FORTH, OR APPENDED, ARE TRUE AND CORRECT TO THE BEST OF HIS KNOWLEDGE AND ABILITY.

DATE ____ TITLE ____ BY ____ SIGNATURE OF AUTHORIZED OFFICIAL

SECTION 35(A) OF THE UNITED STATES CRIMINAL CODE, 18 U.S.C. SEC. 80, MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

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FORM WPB-2774 (6-1-44)

**SECTION II - DESCRIPTION AND STATEMENT OF NECESSITY**

Furnish the following information, referring to the numbers of the following paragraphs:

1. A detailed description of proposed construction, or equipment to be purchased or installed, together with reasons for type, size, and quantity or capacity of facilities to be provided.
2. A statement of the relationship of the proposed construction or equipment to existing facilities; show why existing facilities are inadequate and consequences if this application is not approved.
3. A detailed explanation of the need for the proposed construction or equipment, including a statement of its relationship to military needs, war production, or essential civilian needs.
4. If application is for construction to serve a customer, a description of the customer's plant, project or other property to be served and, where pertinent, quantitative data as to customer's present and estimated future requirements for utility service of the type covered by this application.
5. A statement explaining whether service can be rendered in any other way, or by any other producer or operator, with the use of smaller quantities of critical materials.
6. If extensions or additions to outside plant are involved, a sketch showing the details of the proposal and its relation to existing facilities, including facilities of other producers or operators.
7. A list identifying each exhibit or document attached.

***USE ADDITIONAL SHEETS IF NECESSARY***

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FORM WPB-2774 (6-1-44)

**SECTION III - MATERIALS AND EQUIPMENT REQUIREMENTS**

Show below total materials and equipment requirements for the purposes described in this application, including both items to be purchased and items available in inventory. If this is an amendment show only items on which changes are necessary.

Significant items of materials and equipment must be listed individually. Show requirements separately for each type and size. Where pertinent show also capacity and important operating characteristics. The following list, while not complete, suggests the type of items which must be listed individually:

*Poles and cross-arms*
*Lumber*
*Conductor*
*Communications wire and cable*
*Pipe*
*Steel (structural, reinforcing and plate)*
*Valves and hydrants*
*Fans and blowers*
*Electric relays*
*Pumps, Compressors*
*Switchgear*
*Water treatment plant equipment*
*Power plant equipment*
*Gas production equipment*
*Carrier equipment*
*Telephone central office & PBX equip.*
*Teletypewriters*
*Motors, engines, generators*
*Boilers*
*Transformers*
*Meters*
*Regulators*
*Other items of equipment costing $350 or more per unit to purchase*

You may show opposite "minor items" at bottom of page, without separate enumeration, total dollar value of requirements for such items as:

*Pole Line hardware*
*Conductor accessories*
*Grounding materials*
*Insulators*
*Cutouts*
*Nuts, bolts, washers, etc.*
*Building hardware*
*Pipe fittings*
*Pipe paint*
*Pipe hangers*
*Jointing materials (jute, etc.)*
*Sand, cement, gravel, etc.*

***USE ADDITIONAL SHEETS IF NECESSARY***

| DESCRIPTION OF MAJOR ITEMS OF MATERIAL (a) | UNIT OF MEASURE (b) | NUMBER OF UNITS (c) | VALUE (Dollars) (d) | REQ'D DELIVERY DATE (e) | FOR WPB USE ONLY (f) |
|---|---|---|---|---|---|
| | | | | | |
| MINOR ITEMS | XXXX | XXXX | | XXXX | |
| **TOTAL** | XXXX | XXXX | | XXXX | |

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FORM WPB-2774 (6-1-44)

**SECTION IV - CONTROLLED MATERIALS REQUIREMENTS**

Show below by quarters the quantities of carbon steel (if in excess of 50 tons for all quarters), copper wire and cable (if in excess of 5,000 pounds for all quarters), and aluminum cable (if in excess of 2,500 pounds for all quarters), which must be delivered for the purposes described herein to you, your contractors, or manufacturers of Class A products. Do not include (a) amounts of these materials to be withdrawn from inventory not to be replaced, (b) amounts to be obtained from another utility, or (c) materials required for the manufacture of Class B products. For composite copper-steel or aluminum-steel conductor, show copper or aluminum content only.

| ITEM NUMBER | CONTROLLED MATERIALS (*As classified in CMP Reg. 1*) | UNIT OF MEASURE | ___QUARTER 194___ | | ___QUARTER 194___ | | ___QUARTER 194___ | |
|---|---|---|---|---|---|---|---|---|
| | | | REQUIRED | *FOR WPB USE ONLY* ALLOTTED | REQUIRED | *FOR WPB USE ONLY* ALLOTTED | REQUIRED | *FOR WPB USE ONLY* ALLOTTED |
| | (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) |
| 1 | CARBON STEEL | TONS | | | | | | |
| 2 | COPPER WIRE AND CABLE | POUNDS | | | | | | |
| 3 | ALUMINUM CABLE | POUNDS | | | | | | |

***SPACE BELOW FOR WPB USE ONLY***

***SECTION V* - AUTHORIZATION OR DENIAL; ASSIGNMENT OF PREFERENCE RATING AND ALLOTMENT NUMBER; ALLOTMENT OF CONTROLLED MATERIALS**

Subject to all conditions noted below:

1. The applicant is hereby authorized to proceed as described herein, using materials and equipment only of the kind, type, size, and capacity approved by the War Production Board in Section III; such materials and equipment may be used in quantities required unless specifically restricted elsewhere herein.

2. The preference rating noted below is hereby assigned for the purchase of equipment and materials, other than controlled materials, authorized for use herein, except that ratings specifically assigned in Column (f) of Section III should be used for items so designated instead of the rating assigned below.

3. The abbreviated allotment number U-2 is hereby assigned for the purchase of all controlled materials and Class A products authorized for use herein (except controlled materials and Class A products, if any, for which an allotment is made below in specific quantities and for specific quarters).

4. The applicant is authorized to purchase from other producers and operators, as defined in Utilities Orders, any material authorized for use herein. This authorization constitutes a "specific direction" for the purpose of Utilities Order U-1, and producers with whom orders are placed should be so advised.

5. The abbreviated allotment number and preference ratings assigned herein (and the allotment, if any, made herein) may not be used to order materials and equipment available in the applicant's inventory in excess of a practical working minimum. They may be used to replace materials and equipment in inventory but only to the extent that inventory has been reduced below a practical working minimum. However, in cases where the applicant is a producer as defined in Utilities Order U-1, the applicant is permitted to replace the item used in accordance with the "short item" procedure of Utilities Order U-1.

6. The applicant must not use the abbreviated allotment number or preference ratings (or allotment, if any) to obtain delivery of materials and equipment earlier or in greater quantity than required.

7. Items marked "Limited" in Column (f) of Section III may be used *only* in the quantities approved in Columns (c) and (d) of Section III.

8. Items marked "Inventory" in Column (f) of Section III may be used only to the extent available in the applicant's inventory or in the inventory of another utility, and provided that they are not replaced therein.

9. Orders for controlled materials placed pursuant to this authorization must show allotment number U-2 and must specify the month in which delivery is requested. Orders for materials and equipment other than controlled materials to which the preference ratings assigned herein are applied must also show allotment number U-2 for identification purposes.

10. This authorization is subject to all applicable War Production Board orders and regulations, and to any additional conditions set forth below.

BY ________________________________________________________

SIGNATURE

# The Legal Limits of a Water Supply System

### *By John H. Murdoch, Jr.*

THE 1942 Public Health Service Drinking Water Standards contain a definition reading as follows:

*"Water supply system* includes the works and auxiliaries for collection, treatment and distribution from the source of supply to the free-flowing outlet of the ultimate consumer." According to that definition the "limit" of a water supply system is, at one end the source of supply and, at the other end the free-flowing outlet on the premises of the ultimate consumer.

This definition may appear unimportant and to some water works officials may appear to represent a desirable recognition of the fact that bad interior plumbing may result in contamination of a safe potable water supply. It is certainly desirable that cross-connections with unsafe supplies within the property of consumers and submerged inlets in plumbing fixtures be eliminated. Water works officials must be alert to these problems and should interest themselves in taking steps and devising methods to protect the general system from contamination caused by bad conditions on the property of consumers. But there are limits to our abilities and responsibilities.

The importance of the definition and the reason it is not desirable lie in the fact that once it is accepted in practice that the public water supply system extends to the free-flowing outlet on the premises of ultimate consumers, the general public and consumers and courts and juries will presume that the officials of the water works have assumed responsibility for detection and elimination of all potential health hazards on the premises of all consumers in the entire territory served. When thought is given to the thousands of inspections and re-checks involved, to the laborious, detailed and technical nature of those inspections and re-checks and to the great numbers of installations which would have to be torn out and replaced, it becomes evident that the job is one beyond the resources and abilities of any water works organization. In good conscience the water works cannot lull the community into a sense of security by giving the impression that the water works system is free of sanitary defects to the last outlet on each individual consumer's property. No water works should assume responsibility beyond its power to meet the obligations of that responsibility. The quoted definition is an attempt to have the water works assume responsibility for detailed policing of interior plumbing on

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A paper presented on June 15, 1944, at the Milwaukee Conference by John H. Murdoch, Jr., Attorney, American Water Works & Elec. Co., New York, N.Y.

consumers' premises and therein lies its importance. The impossibility of adequately meeting the new obligation is the reason the definition is not desirable.

This paper is presented as a discussion of the propriety of the quoted definition and of the legal consequences which would follow our acceptance of that definition.

## Legal Limit as Established by Common Law

No attempt will be made to examine the statutory or case law of the states touching on our question or to cite authorities, but rather to present some legal principles believed to have general acceptance in America as being established by common law. In a later section consideration will be given to possible methods by which the legal limit so fixed may be modified or changed.

Except as restricted by the police power, the owners of real property in America have the absolute right to hold, control and use that property and no other person has the right to enter on or interfere with it.

Where a stranger has no *right* to enter or interfere, the stranger has no *obligation* to enter. Where property and facilities are under the exclusive control of one person, another person has no right and no obligation to assume jurisdiction over that property or those facilities. Each person looks after and manages his own property, being careful to observe the limits of his property rights. Those are fundamental principles of American law and, in recognition of them, it has been customary to draw the line marking the legal limit of the water supply system at the property line or, for convenience, at the curb line. The allocation of rights and responsibilities is made by reference to that line.

Thus the water supply agency usually installs the service line from the street main to the property line and is responsible for the adequacy and the maintenance of that line. On the other hand, the consumer or the property owner installs and maintains the water lines from the property line into and throughout the premises. The property owner has control over his own property and need not permit a stranger to enter and lay or maintain lines.

When service lines freeze between the main and the property line, the water supply agency is usually responsible for thawing, but when the freeze occurs on the consumer's side of the property line, the consumer attends to the thawing.

On complaint of inadequate water service on a consumer's premises, the first fact to be developed before a regulatory commission hearing the complaint is whether adequate or reasonable pressure and quantities are available *at the property line* end of the water supply agency's service line. If they are, then the inadequate service is caused by conditions on the property of the consumer and the consumer will have the responsibility, at his own expense, of bettering the conditions.

The basic right of property which gives the owner the control and exclusive use and occupancy of his property is so well understood and so universally recognized and respected that cases directly referring to it are rare. However, the results which flow from that basic right of property so recognized are constantly considered by

legislatures and courts. The water works supply customs here mentioned all derive from this basic property right. Property rights have fixed the legal limit of the public water supply system at the property line.

### Modification of Customary Legal Limit by Contract

There are many water supply systems which by contract acquire rights within the property lines of consumers, and such contracts may be said to modify the legal limit. In systems in which water service charges are based on the number and types of attached facilities, the consumer, in taking service, is assumed to have agreed that representatives of the water supply agency may enter at reasonable times to make inspections of the attached facilities or to check for unnecessary wastage of water. Where meters are installed on consumers' premises the consumers are held to have contracted to give the right to set and maintain and read the meter. In these and similar cases the legal limit has not really been changed, but rather modified by the giving to the water supply agency a limited right in territory which would, except for the contract, be "out of bounds." The true legal limit is still the property line within which the owner is in control.

It has been said that representatives of a water supply agency have the right to enter consumer's premises to detect leaks. These supposed rights appear usually as instances of rights of entry granted by contract as just mentioned, as in instances where the consumer has asked for help, frequently in connection with an unusually large meter reading. The latter cases are not even modifications of the legal limits.

### Modification of Legal Limits by Exercise of Police Power

Before mentioning ways in which the legal limits of a water supply system may be modified through the exercise of the police power, it is necessary to consider the nature of that power and restrictions on its use.

In McQuillin's *Municipal Corporations* it is said that,

> the police power authorizes the enactment and enforcement of laws and regulations requiring each citizen so to conduct himself and so use his own property as not unnecessarily to injure another. The police power is defined by Blackstone to be the power which concerns "the due regulation and domestic order of the kingdom, whereby the individuals of the state, like members of a well-governed family, are bound to conform their general behavior to the rules of propriety, good neighborhood and good manners, to be decent, industrious and inoffensive in their respective stations."

The police power is a much greater, broader power than the power and authority of the organized police force. That organized police force is merely one agency by which the sovereign state attempts to enforce laws enacted under the police power. When a policeman makes an arrest he is supposed to be exercising the state's right to restrain one who has violated a prohibition established under the police power.

The following quotations are also taken from McQuillin, *Municipal Corporations:*

> The exercise of this power necessarily interferes in some respects with the liberty of the citizen, as his right to move about as he pleases, or his right to follow in his own way any lawful occupation, or his right in the use of his property. This interference is justified solely on the ground that it is required in order to protect the personal and property rights of others, and advance the

best interests of society. . . . All businesses and occupations and all movements and activities of the citizen in public relations, it is important to remember, are carried on subject to the reasonable exercise of this power. Obviously individual freedom must yield to the enforcement of just regulations for the public good. Appropriate and reasonable legislation or regulation by nation, state or city, therefore, is sanctioned which has for its object the promotion of the public safety, health, convenience and general welfare, or the prevention of fraud and immorality.

"It may be said in a general way," remarked Mr. Justice Holmes, "that the police power extends to all great public needs. It may be put forth in aid of what is sanctioned by usage or held by the prevailing morality or strong preponderant opinion to be greatly and immediately necessary to the public welfare" (219 US, 104).

Organized government has the inherent right to protect health, life and limb, individual liberty of action, private property and legitimate use thereof, and provide generally for the safety and welfare of its people. . . . Safeguarding the public welfare then in its most comprehensive sense is the basis which justifies the exertion of the police power and the imposition of restrictions on individual action and the use of property.

It should be observed that the police power is not unlimited. Attention is directed to certain points in the quotations.

The exercise of the police power is justified only when it is *required* in order to protect others and advance the best interests of society. The exercise of the power must be *reasonable*. The regulations must be *just, appropriate* and *reasonable* and must be *greatly* and *immediately necessary* to *public welfare*. Unless a regulation under the police power meets these standards the regulation is invalid and unenforceable.

One final quotation from McQuillin:

Of the exercise of this power to govern as applied to restrictions on the use of private property, it may be remarked that restrictions are justified only when necessary to preserve or promote the public health, morals, safety, comfort, convenience or general welfare of the community. When the use of property does not infringe the rights of others, or limiting its use is not essential to the legitimate exercise of the police power, or when required, where the restrictions imposed pass beyond that which is reasonably necessary to safeguard public welfare, limitations of the use of the property on the part of the owner are not a lawful exercise of the power of sovereignty, but merely an abuse of power resulting in oppression, and are forbidden by the organic laws of the nation and state.

It has long been recognized that the health of a community would be endangered if a consumer were permitted, on his own premises, to cross-connect a polluted water supply with the public water supply. Obviously, open cross-connections between the two supplies could probably result in the drawing of polluted water into the public system. Police power regulations are, therefore, in force almost everywhere forbidding such cross-connections and giving representatives of water supply agencies the right to inspect points of possible cross-connections and the right to discontinue the public supply when improper cross-connections are found. These regulations impose on the property of the consumer a right of inspection by health officers, and often by water supply agency representatives, and thus result in a modification of the legal limit. The regulation is a valid exercise of the police power because it is necessary to the public health that cross-connections on consumer premises be forbidden and because the rights given health officials and water supply representatives are rights which are appropriate to safeguard the public.

Such regulations do not make the interior piping on each consumer's premises a part of the public water sup-

ply system, but merely limit the rights of the property owner in the use which he may make of his own property. The inspecting officials are charged by law with a duty to make inspections only where they know a secondary supply is available which might easily be cross-connected. There is an absolute prohibition against improper cross-connections and a right, as against the property owner, to make reasonably necesssary inspections and to discontinue service if improper cross-connections are found, but the responsibility to make inspections is a limited responsibility. The legal limit of the public water supply system has not been changed from the property line by such regulations.

For many years health department regulations and water works literature maintained a clear distinction between cross-connections and inter-connections. The first was a connection between an approved primary public supply and a secondary source of supply not of approved quality. Inter-connections covered all interior plumbing arrangements not involving a secondary source of supply which might result in admitting contamination to the potable supply. Traditionally, the distinction was insisted on in recognition of the facts that true cross-connections were few in number and were usually well known as to location and presented a very real and ever-present health hazard, while on the other hand, inter-connections were legion in number, their locations unknown and they could result in contamination of the general system of potable supply outside the premises directly involved only as a result of rare and unusual combinations of circumstances. Unfortunately, this important distinction between cross-connections and inter-connections is specifically and in definite terms done away with in the new Drinking Water Standards, as well as in the model codes being advocated by some state health departments.

As to inter-connections as formerly defined, police power regulations limit property rights. Plumbing ordinances provide a prohibition against installation of unapproved types of plumbing, but it has not been usual to require the elimination of such plumbing if installed before the date of the regulation unless contamination is discovered. Plumbing inspectors and health department officials are usually given a right of entry on private property to examine conditions in the plumbing system and such regulations and inspection rights constitute limitations on property rights. These are valid exercises of the police power because it is reasonably necessary to lessen the chances of contamination of the potable water supply within the premises and because the inter-connections might in rare instances contaminate the general supply.

No responsibility has been placed on water supply agencies to police consumers' premises in a search for possible inter-connections by such regulations. Even trained plumbing inspectors are compelled to content themselves with inspections made pursuant to applications for permits to change or install plumbing or to premises where suspicion has been aroused by bad health records. A police regulation which would attempt to subject all premises to regular inspection and which would require the elimination and destruction of all installations, no matter when installed, which failed to measure up to modern standards, would probably be held to be invalid as not reasonably necessary or appropriate.

The police power regulations dealing

with cross-connections and inter-connections seem to impose valid limitations on the rights of property owners or consumers, but only impose duties on the public water supply agencies when they know or should know of conditions on consumers' premises constituting hazards to the general supply in the system. Such regulations do not change the legal limit of the water supply system. Even under the most strict of those regulations the legal limit of a water supply system is still at the property line.

It would be an invalid attempt to exercise the police power should regulations be adopted which would require a water supply agency to police the interior plumbing on the premises of all its consumers. Such a regulation would be invalid because it would be unreasonable as requiring an impossibility, and, secondly, because the remedy provided by the regulation would be unnecessary and inappropriate in attempting to impose on water works operators duties and responsibilities already properly imposed, in the essential features, on the health authorities of the municipality or the state with adequate power and technical ability to perform such duties.

## Customary Definition of Water Supply System Compared With Definition in 1942 Drinking Water Standards

Traditionally, the legal limit of a water supply system has been the property line with the rights of the property owner on his own property limited by contract or valid police regulation. The definition of a water supply system based on that legal concept would be:

"A water supply system includes all the works and auxiliaries for collection, treatment and distribution of water from the source of supply to the property line of the ultimate consumer."

The 1942 Drinking Water Standards by definition add to the system all the facilities, plumbing fixtures, spray heads and even garden hose lines and nozzles on consumers' private property, if directly or indirectly connected to the public supply lines. Any item in this added territory not measuring up to modern standards would be considered a "sanitary defect" in the water supply system, and, unless ignored by the state department of health, would prevent water from the system being certified by the Surgeon General of the United States as satisfactory for drinking water on interstate carriers. The result of such failure of certification would be considered as a reflection on the local water supply agency, although that agency could have no effective control over most of the "system" as so defined.

## Possible Legal Effects of Acquiescence in New Definition

A water works operator has the legal responsibility to install, maintain and operate reasonably adequate and safe facilities. A water works operator who fails to provide the facilities or service practices, which the consensus of opinion of such groups as the American Water Works Association generally hold to be needed to assure reasonably safe service, would be held guilty of legal negligence. If a failure on the part of a water works operator to bring his system or his operating practices up to the standards accepted by such a group as this is followed by injury and damage to a consumer of water and that injury is the result of the failure, then the water supply agency would be liable for damages. That is the legal situation now and it should continue to

be the situation because we have the legal obligation to provide the facilities and the operating practices which are reasonably needed. No court or jury would ever decide that what this Association deemed to be required by good practice was not reasonably necessary. It is, therefore, vitally important to the members of this Association that nothing be done by the Association tending to indicate that consumers' plumbing and fixtures are or should be under the control of the water supply agency as being part of the water supply system. That is not to say that the water supply agency representatives should be indifferent to sanitary defects on consumers' premises. Where dangerous defects are known to exist or where the water supply operators are in position to know of such defects by exercising ordinary powers of observation and deduction, the water supply operators are in duty bound to take steps to guard against contamination of the general supply. There is, however, no legal or moral obligation on a water works operator to undertake the impossible task of inspecting all consumers' premises for sanitary defects. Indeed, there would seem to be a moral obligation to make it plain to all concerned that such inspections are not made and that, so far as the water supply agencies are concerned, the limit of the public water supply system is the property line.

### Conclusion

Water works operators must be interested in potential health hazards which may affect the potable water supply. There is a moral responsibility on the operator to use his influence to bring about better plumbing practices. There is a moral responsibility to take necessary action within his rights and abilities to remove the hazard to the system from sanitary defects which he knows exist or should know exist. The water works operator should not let it be presumed that he has promised to perform that which he cannot perform.

## Discussion

### Boyd A. Bennett *

Any discussion of drinking water standards by water works operators should be prefaced with a reminder that the operator has a moral and legal responsibility for the installation, maintenance and operation of reasonably adequate and safe facilities, producing a pure and wholesome water supply. The operator should not be indifferent to sanitary defects, and when defects are known to exist, it is his duty to take steps to correct the hazard.

Mr. Murdoch has ably presented to you, the legal liability of the water supply agency in connection with the United States Public Health Service, December 3, 1942, Drinking Water Standards. He has called to your attention certain police powers granted to the water supply agency representatives and their rights on private property, also that such police powers must be reasonable. He has mentioned the probability that if an operator does not follow operating practice standards, approved by a recognized group such as the American Water Works Association,† the water supply agency would

* President, Water Utilities Service Corp., New York, N.Y.

† A record of the relationship of A.W.W.A. in connection with the Drinking Water Standards, was published in the Jour. A.W.W.A. **36**: 781 (1944).

be liable for damages, should injury or damage result from non-compliance with such reasonable standards.

It is recognized that the U.S.P.H.S., acting under its interstate quarantine authority, has specific supervision over the quality of the water actually used or offered to the public for use by common carriers. Any regulation that specifies how this water is secured involves dealing directly with local water supply agencies, which seems to be beyond the scope of interstate quarantine regulation. Any attempt so to regulate is one more step in the direction of centralized control by federal government agencies, and limits state control to that of a reporting agency. State or local departments have no direct jurisdiction over interstate traffic and, hence, they are asked to act under a separate provision of state or local laws which apply to all public water supplies, whether or not they serve common carriers.

The local water supply agencies have certain powers and duties, based on entirely independent laws, codes or ordinances. These powers and duties are supplemented in many municipalities by independent plumbing regulations and codes, administered by local health and building regulations and inspection. Efforts have been made to grade water supplies according to the quality. Comparisons such as these are useful, but their place is not in the law such as this standard under discussion. Under the police power, a water supply is injurious or not injurious to health—there must be no debatable ground. If, under this standard, a water supply is not certified, it is considered by the public to be injurious to health if it cannot be used by common carriers. If a standard or manual of practice were set up by the water industries, sanitary engineers and public health associations as an incentive to improvement, it would be quite different from an order by the U.S.P.H.S. requiring certification of a public water supply. Since the document under discussion is fundamentally related to the certification of water supplied for common carriers in interstate commerce, and the regulation governs only the quality of water, the question is asked: How will the U.S. P.H.S. legally be able to concern itself with enforcement of the order in all its parts under the different forms of state and local laws now in force?

## State Health Department Rulings

About a year ago, a hotel was taken over by the U.S. Army. The water agency was requested to increase the chlorine dosage at the pump station in order to give a residual of at least 0.3 ppm. at the hotel, because the army engineers could not get a satisfactory test from the water in the hotel. If this request had been carried out by the water agency, the chlorine content of the water would have been so strong that the customers between the pump station and hotel would have been unable to drink it. At the suggestion of the water agency, an inspection of the hotel plumbing was made in the company of the army engineers. This inspection revealed a siphon into the water piping from the sewerage plumbing on the second and third floors. Discontinuance of the supply would have been necessary until a new plumbing job had been completed in the hotel by its owners. However, under the conditions and at the request of the state health department, the water agency increased the size of the service from the main to the property line and the Army took its water from this point

and installed its own chlorination treatment within the building beyond the meter.

The state health department ruled that the water company's responsibility ended at the property line and the Army responsibility commenced at that location. Under the standards of the U.S.P.H.S., if an injury had occurred, the responsibility would have been on the water agency.

In a town in New England, 30 per cent of the public water supply customers have an additional supply from wells and a so-called aqueduct supplying company, neither of which are treated. These customers pay the public water supply agency a minimum charge for the public supply, and about once a year call on the public supply for service for at least one-quarter, because of the failure of the other supply. The state health department requires the disconnection of the two supplies within the premises, eliminating any cross-connection. However, to comply with the standards under discussion, the water supply agency would have to inspect and sterilize all of the plumbing and plumbing fixtures on each of the premises, every time the public water supply was used. There are probably many similar conditions at other locations.

Many operators have probably had the experience of bad water samples from hotel or restaurant fixtures. The state health department, having been called in to make an examination and inspection, has found that one or more employees are disease carriers and every time the disease carrier touched the spigot it became contaminated. To live up to the letter of the standard regarding water supply system, health hazard and sanitary defects, would require not only routine inspection of all customers' fixtures, but constant inspection and regular bacteriological check of all free-flowing outlets on each consumer's property. Inspection would reveal only mechanical possibilities for contamination, so that a bacteriological determination would be required to ascertain actual contamination.

## Possibilities of Contamination

Any and every free-flowing water outlet is subject to contamination at all times as the result of being touched by the hands, lips, some foreign object, substance or matter. This leads to the possibility of charges of contamination of the water by the ultimate consumer after the water has been drawn into a container furnished by the ultimate consumer. Practically all water drawn by the consumer is caught in a container before being used. Even though the water from the nozzle of the free-flowing outlet may be bacteriologically safe, still the container may carry, and most likely does carry, bacteria which would immediately contaminate the water. It is impossible to anticipate that any container used by the consumer in his daily life will ever actually be sterilized immediately before being used to catch the water from a free-flowing outlet.

A good example of this: The Army stationed 250 Air Corps cadets in a Normal School building. The Medical Corps sent to the commandant of the school a sterilized sample bottle in which to take a sample of the water furnished to the school, to be used by the Medical Corps to make a bacteriological determination of the water. The sample taken was reported by the Medical Corps as showing contamination by *Escherichia coli*. Investigation proved the water to be bacteriologically

safe. It seems that a sergeant, who had never taken a sample of water before for bacteriological determination, had not sterilized the nozzle of the drinking fountain before taking the sample, and had not observed any precautions in the handling of the sample bottle. If a sample of bacteriologically safe water taken in a sterilized bottle by a responsible representative of the Army Medical Corps is contaminated in the process, it certainly is beyond the police powers given to any water supply agency to supply bacteriologically pure water to miscellaneous unsterilized fixtures or containers furnished by the consumer on his premises.

## Cross-Connection Hazards

The present state or local laws give water supply agencies some limited rights to disconnect service on the basis of being a nuisance and a hazard to the community. Even in the case of cross-connections, some state health departments are very reticent about taking drastic action to compel the consumer to eliminate such cross-connection or other hazard. An example was called to the author's attention some time ago of a private hospital refusing to eliminate a cross-connection between its own supply and public supply, even after an order from the state health department, and daring the water supply agency to discontinue service. It is the author's understanding, that the condition still exists.

The standard is so broad that it imposes on the water supply agency a paternal rôle. The phrase "contaminated from an extraneous source" is so far reaching that its interpretation might place the burden of police duties on the water supply agency, without the power to enforce them. The federal government has already made federal tax collectors out of private electric utilities and many other private enterprises—maybe it can make policemen out of water supply agencies.

## Impossible Demands

It would be almost impossible to supply sufficient employees to make all the inspections required by the standard. A bacteriological determination would have to be made of each outlet, after each had been used. The water would have to be cut off from the premises and each fixture inspected for any siphoning action or other hazards. A great number of water customers are tenants and, therefore, cannot be held responsible for plumbing fixtures and enforcement against tenants for plumbing could not be made by discontinuance of service. A U.S. P.H.S. representative inspecting a water plant suggested that added samples at added localities throughout the distribution system be taken daily and examined. The estimated cost of this plant of 4,000 customers, for such added samples, was $1,500 per year.

The lowest estimate of cost for inspection of premises once each year, from sixty-odd plants to which the question was put by the author, was $1.00 per customer. The majority of the plants queried were of the opinion that it would take two men to make an inspection and 1 hr. per inspection should be allowed to cover necessary office time, travel time, inspection time, etc. To sum up, the estimated cost of complying with the standard would be ruinous. One city manager wrote the author: "I would not even hazard a guess at the cost to comply with the requirements of the standard."

As the standard now stands, the water supply agency is responsible for conditions over which it has no control by rule, regulation, police power

or any other law or order. The author knows of no reason why the water supply agency should be responsible for its product beyond a safe water at the property line, any more than the milkman should be required to assume responsibility for his milk after he leaves the bottle on the door-step.

If the responsibility has to be placed on someone, and if the state or local health department is selected, personnel required in these times would be impossible to obtain. The same would be true if responsibility were placed on the Building Code Inspection Department. The tariffs, as now fixed for water supply agencies, either by state regulatory bodies or local councils, are not large enough to carry the excess cost of the work made necessary by the responsibility placed on them by the Drinking Water Standard requirements under discussion.

The Drinking Water Standard should be reviewed and modified to make it just, reasonable and practicable of operation and enforceable under police power when the necessity to public welfare requires; it should not be too specific but should be elastic as to interpretation by the reporting agency, and not impossible of compliance by the water utility as it is now. The realistic way to correct the standard or the intent of it, is to restate the limit of the supply system to be the installation from its source to the delivery point at the consumer's property line.

### J. K. Hoskins †

The paper presented by Mr. Murdoch is a clear exposition of the legal rights of a water purveyor with respect to entry on private property. Perhaps a brief statement concerning the reasoning and viewpoint of the Public Health Service with regard to the definition of a water supply system as given in the Drinking Water Standards will be of interest to those concerned with this definition.

The Public Health Service does not agree that this definition places the legal responsibility for sanitary conditions beyond the meter solely on the water purveyor. From the public health viewpoint and for the good of the ultimate consumer health hazards and sanitary defects should be eliminated whether they exist on one side or the other of the property line or meter. If not, whatever steps may be taken by the water purveyor to safeguard the water supply may be cancelled by other steps taken inside the property line.

The water supply system was defined in the Drinking Water Standards so as to be all-inclusive in order to implement the necessary inspection and control by those having jurisdiction. A number of agencies may be involved: health authorities, municipal plumbing and building authorities and possibly others in addition to the water purveyor. The proper authority should take up the problem where its jurisdiction controls and that of the other authorities ceases.

The Public Health Service is cognizant of the fact that there are limitations in the legal rights of a water purveyor with respect to entry on private property. However, this limitation does not justify ignoring a situation which all familiar with water systems and house plumbing know exists. Unless there is a recognition of the problem and co-operation on the part of all having jurisdiction toward elimination of sanitary defects and health hazards, the protection of the ultimate consumer against such hazards is incomplete.

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# The Economics of De-Ionized Water Supplies

*By Frank Bachmann*

THE development of ion exchange materials in the past 10 yr. has opened up new applications of these materials in water treatment. Water can be treated to remove the hardness ions, i.e., calcium and magnesium; all of the alkalinity; and all of the de-ionizable salts. Moreover, mixtures of the effluent from these steps can be proportioned to give a finished water which will meet almost any specification. This discussion will be confined mainly to the application of ion exchange materials to municipal supplies.

De-ionization, demineralization or desalting of water may be defined as a process in which ions are partially or completely removed from an aqueous solution by ionic exchange or by acid adsorption. This definition does not include zeolite treatment or treatment with any cation exchange material operating in the sodium cycle, as this treatment does not reduce, but actually increases, the dissolved solids in the water to the extent of the chemical equivalents of the ions exchanged. Where softening is required, zeolites and organic ion exchangers still have a very definite place in the water works field.

The newer types of exchange materials are strictly organic in composition and have no similarity in chemical composition to the zeolites. It is believed that the term "organic zeolite" is a misnomer and that the Committee of Nomenclature of the American Water Works Association should study the matter and decide on a name to cover all of these materials. The late Robert Spurr Weston, in his discussion of Goudey's paper (1), pleads for a simpler expression of the capacities of the exchangers than "grains per cubic foot" and suggests the use of "pounds per cubic foot." Similarly, regenerants used may be in terms of a pound of commercial acid and alkali of definite strength per pound of ions, as $CaCO_3$, removed.

Names which have been used for these organic ion exchange materials are: Organolites; Organic Ion Exchangers; Electrolyte Exchangers; Ion, or Ionic Exchangers; De-ionizers; Demineralizers; Cation Exchangers; Anion Absorbers; etc. There are to date some 15 or more of these materials on the market, usually with a separate name for the cation and anion exchangers, as each manufacturer has his own trade name for the material. The trade names are important to the manufacturer in designating the type of material recommended for the various applications. These trade names need not conflict with a suitable name to

A paper presented on June 14, 1944, at the Milwaukee Conference by Frank Bachmann Water Specialist, The Dorr Company, New York, N. Y.

cover all types of these organic ion exchange materials. Some of the exchangers and trade names follow:

| *Cation Exchangers* | *Anion Exchangers* |
|---|---|
| Amberlite—IR-1 and IR-100 | Amberlite—IR-4 |
| Zeo-Karb | De-Acidite |
| Catex | Anex |
| Grahycarb | Grabasic |
| Nalcite "A", "AX" and "MX" | |
| Ionac—C-284 | Ionac—A-293 |
| Duolite—C-1 and C-3 | Duolite—A-2 |

Capacities of the above cation exchangers vary from 6,000 to 20,000 grains per cu.ft. and on the anion exchangers from 7,000 to 30,000 grains as $CaCO_3$ per cu.ft. Higher capacities are claimed for the more recently developed materials. Manufacturers have the following points in mind when developing new materials:

1. Maintenance of high capacity per unit of weight or volume.
2. Low chemical requirements for regeneration.
3. Stability as to both chemicals and attrition.
4. High removal of salts.
5. High velocity of exchange permitting output in shorter time.
6. A sharp "break-through" point.

It is gratifying to report that preliminary tests of some newer materials meet most of these requirements.

There is not too much known as to the life of these exchangers as they have not been in service for a sufficient length of time. The cation exchangers' losses due to attrition and loss of the fines by backwash are estimated at 5 per cent per year. Cation exchangers have been in service longer than anion exchangers and more data are available on these materials. The life of a cation exchanger is estimated by one manufacturer as 40,000 cycles. Assuming two cycles per day, the life of this exchange material would be over 50 yr. No definite estimate of the life of anion exchangers has been published but some of these materials are stated to compare favorably with the life of the cation exchangers. More definite information on this subject will be available as more plants are installed and operating data are made available.

There are two types of these organic exchange materials, namely cation exchangers and anion adsorbers. The cation exchangers are believed actually to exchange chemically ion for ion, whereas the anion exchanger acts as an adsorber attaching the acid radical to the exchanger material. The equations (2) in Table 1 illustrate the actions taking place when water is passed through these materials.

All reactions for the cation exchanger are reversible, depending on the concentration of salts present.

The above equations indicate the possible use of these exchange materials in the water works field. For instance, where softening alone is desired, the cation exchanger can be used in the sodium cycle to remove calcium and magnesium. The exchanger is regenerated with salt similar to the present practice with zeolites. These exchangers are superior to zeolites in that usually they have a higher capacity, a greater pH range in the raw water and they do not increase the silica content of the water.

The cation exchanger, when regenerated with acid (usually sulfuric), operates in the hydrogen cycle and exchanges the metallic ions of Ca, Mg, Na and Fe to hydrogen. The chlorides, sulfates, nitrates and carbonates are changed to their acid derivatives

HCl, $H_2SO_4$, $HNO_3$ and $H_2CO_3$, respectively. The effluent from the cation exchanger is, therefore, acid to the extent of the chlorides, sulfates and nitrates present in the raw water. The mineral acids require neutralization by the alkalinity in the blending with raw water, cation exchanger water operated in the sodium cycle, or by passing through an anion cell. The carbonic acid produced in the process is a gas which is removed by an aerator or a degasifier.

Where practicable, treatment by cation exchanger in the hydrogen cycle with blending with raw water will usually be cheaper than the installation of both types of cation exchangers where total removal of hardness is not an important factor. No generalities can be given on the application of hydrogen-cation exchangers as each problem must be studied with a view of obtaining the desired results at the least cost.

De-ionization of water is particularly of interest to municipalities where

TABLE 1

*Cation Exchange Reactions*

| | |
|---|---|
| *Sodium Cycle* (Softening) | $2NaX + Ca(HCO_3)_2 \leftrightarrow CaX_2 + 2NaHCO_3$ |
| | $2NaX + Mg(HCO_3)_2 \leftrightarrow MgX_2 + 2NaHCO_3$ |
| | $2NaX + CaSO_4 \leftrightarrow CaX_2 + Na_2SO_4$ |
| | $2NaX + MgCl_2 \leftrightarrow MgX_2 + 2NaCl$ |
| *Hydrogen Cycle* | $2HX + Ca(HCO_3)_2 \leftrightarrow CaX_2 + 2H_2CO_3$ |
| | $2HX + Mg(HCO_3)_2 \leftrightarrow MgX_2 + 2H_2CO_3$ |
| | $2HX + CaSO_4 \leftrightarrow CaX_2 + H_2SO_4$ |
| | $HX + NaNO_3 \leftrightarrow NaX + HNO_3$ |
| | $HX + NaCl \leftrightarrow NaX + HCl$ |

*Note:* X represents the exchanger.

*Anion Exchange Reactions*

| | |
|---|---|
| *Acid Removal* | $2XA + H_2SO_4 \rightarrow (XA)_2 \cdot H_2SO_4$ |
| | $XA + HCl \rightarrow XA \cdot HCl$ |
| | $XA + HNO_3 \rightarrow XA \cdot HNO_3$ |

*Note:* Where XA is exchange material with the acid binding substituent A

Neutralization of the acids by passing the effluent of the cation exchanger effluent through anion exchanger cells results in a water equivalent to distilled water and will be discussed under "Complete De-ionization."

The combination of cation exchangers operating in the sodium and hydrogen cycle (3) has many applications. It will reduce the total dissolved solids materially on high carbonate waters and reduce the alkalinity to a point where the water is suitable for certain industrial uses. It also yields a soft water.

excessive sodium bicarbonates are present in the raw water or where the chloride or sulfate content, or both, are intolerable. In either of these cases, it is impractical to remove all of these salts. The treatment should consist of completely de-ionizing part of the water and blending it with raw water to obtain a final water satisfactory for municipal use. De-ionization is not a cheap method of treating water nor is it a substitute for present methods of municipal treatment. This method, therefore, should be limited to special

problems as mentioned, i.e., reduction of chlorides, sulfates, magnesium and sodium bicarbonates, where these are present in excess of standards of purity set up by health authorities. The cost of treatment of the water in these cases should be compared to the cost of obtaining a new supply requiring little or no treatment.

## Sodium Bicarbonate Waters—Plant "A"

Waters containing high concentrations of sodium bicarbonate can be successfully treated with cation exchangers operated in the hydrogen cycle. An illustration is a plant recently installed in an army camp. The raw water is taken from an artesian well 1,900 ft. deep. The temperature of the water is 97°F. The well has a free flowing capacity of 160 gpm. but, as 450 gpm. were required, a deep well pump was installed with this capacity. The high sodium bicarbonate content makes this water unfit for drinking or general domestic use. It is unfit for making tea or coffee and discolors certain foods cooked with it.

The present plan of operation consists of discharging the well water into a grit removal basin from which it enters a raw water pump well. It is then pumped to a splitter box where the water is proportioned, a part being used for treatment and a part for blending purposes. The water for treatment is discharged into either of two cation exchangers operated in the hydrogen cycle, then blended in the proportion of 50 per cent raw water and 50 per cent treated water, degasified and then pumped into the mains (Fig. 1, 1a).

The exchanger cells are open wood stave tanks with Amberlite IR-1 as exchange material, and are operated by gravity. When the cells are exhausted, the exchange material is regenerated with dilute $H_2SO_4$, using a three-stage regeneration method, which was developed by the company represented by the writer. By the use of this multiregeneration system, it is possible to reduce the acid requirements materially. During the actual performance test on this plant, less than 125 per cent of the theoretical amount of $H_2SO_4$ was used to displace the cations in the raw water, including that used for rinse, backwash, chemical make-up and finished water.

The analysis of the raw, treated and blended water is given in Table 2.

TABLE 2

*Treatment of High Sodium Bicarbonate Water—Plant "A"*

*(Results expressed in ppm. as $CaCO_3$)*

| | *Raw* | *Treated* | *Blended 50% Raw + 50% Treated* |
|---|---|---|---|
| Hardness | 5 | 0 | 2 |
| Sodium | 1465 | 40 | 753 |
| Alkalinity | 960 | — | 245 |
| Acidity (Mineral) | — | 470 | — |
| Sulfate | 0 | 0 | 0 |
| Chloride | 510 | 510 | 510 |
| Carbonic dioxide (as $CO_2$) | 0 | — | 5 |

From the analysis it will be noted that the hardness and sulfates are negligible in the raw water, whereas bicarbonate and chlorides of sodium are very high. The specifications required the reduction of alkalinity to 250 ppm. The treatment of 50 per cent of the raw water through cation exchangers operated in the hydrogen cycle and blending with 50 per cent of raw water met the specifications.

High chlorides (510 ppm.) are present in the raw water and still exist in the same amount in the finished water. They are much higher than recommended by the U. S. Drinking Water Standards. They can be removed by

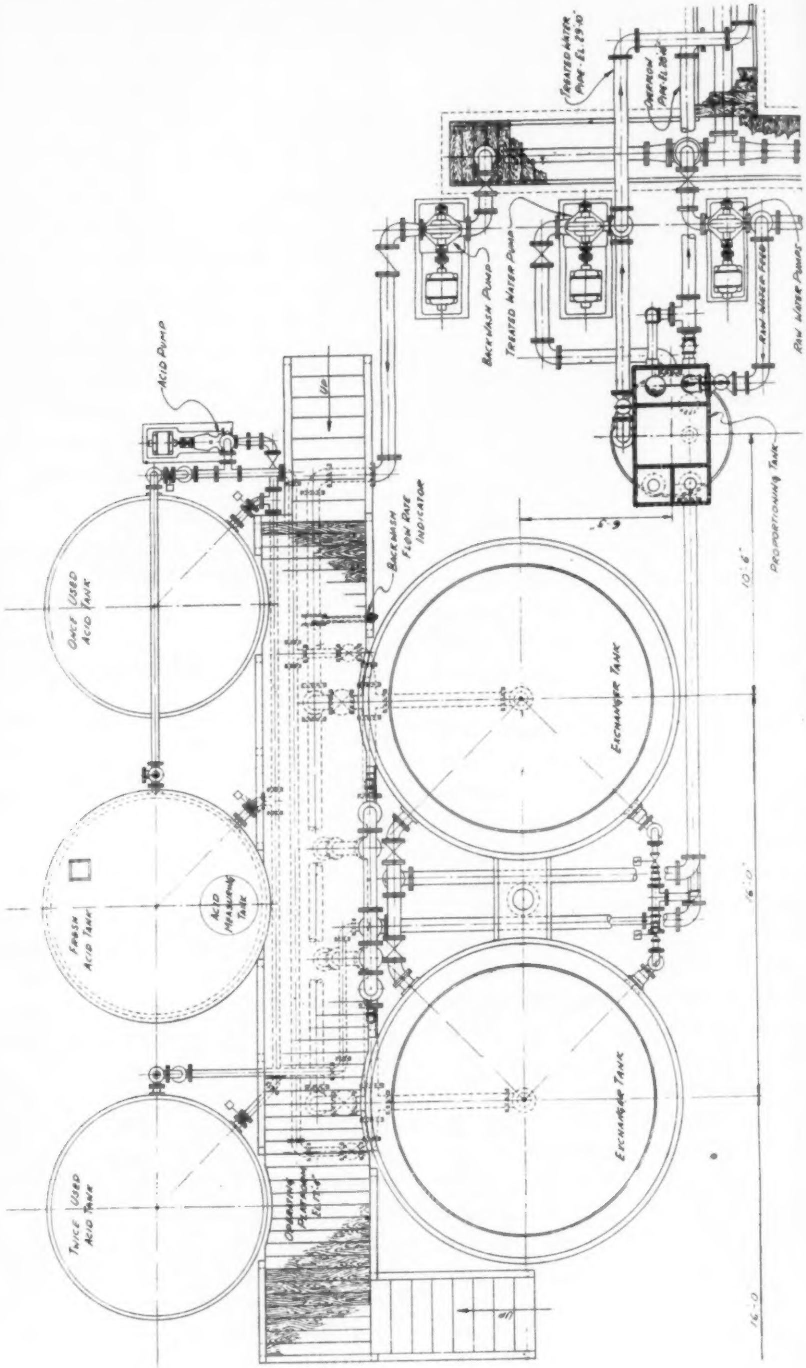
ACID PUMP
UP
ONCE USED ACID TANK
FRESH ACID TANK
ACID MEASURING TANK
TWICE USED ACID TANK
BACKWASH FLOW RATE INDICATOR
EXCHANGER TANK
EXCHANGER TANK
BACKWASH PUMP
TREATED WATER PUMP
RAW WATER FEED
RAW WATER PUMPS
PROPORTIONING TANK
10'-6"
16'-0"
16'-0"
UP

FIG. 1.

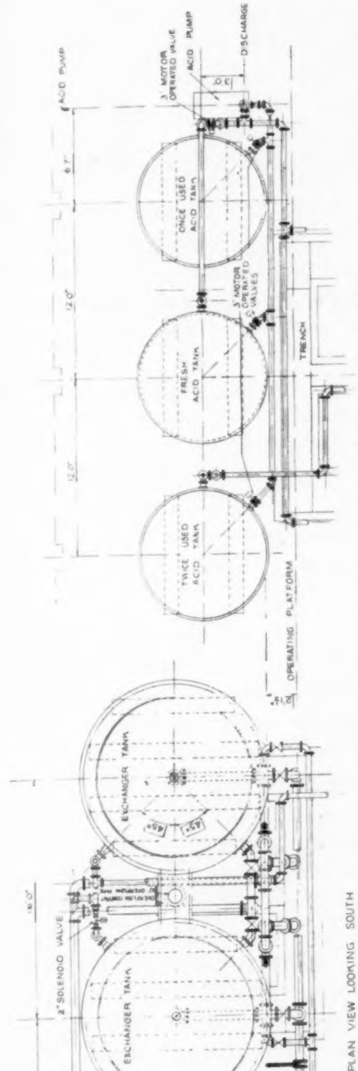
EXCHANGER TANK
EXCHANGER TANK
2" SOLENOID VALVE
PROPORTIONING TANK
MIXING TANK
PLAN VIEW LOOKING SOUTH
TWICE USED ACID TANK
FRESH ACID TANK
ONCE USED ACID TANK
ACID PUMP
DISCHARGE
OPERATING PLATFORM
TRENCH
PLAN VIEW LOOKING NORTH

FIG. 1.

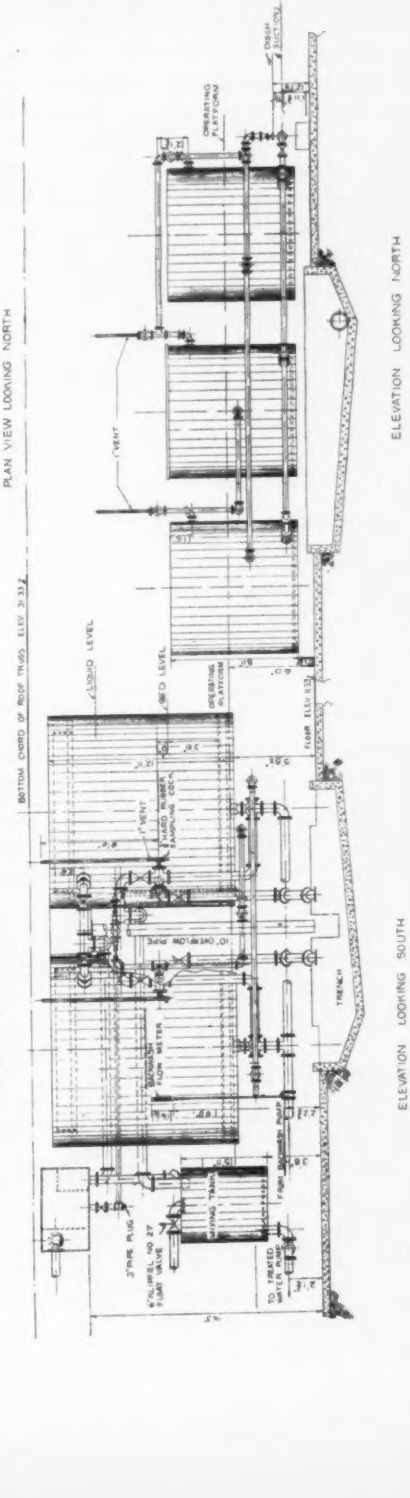
BOTTOM CHORD OF ROOF TRUSS ELEV 31.33
LIQUID LEVEL
BED LEVEL
OPERATING PLATFORM
BACKWASH FLOW METER
MIXING TANK
TRENCH
1" VENT
ELEVATION LOOKING SOUTH
ELEVATION LOOKING NORTH

FIG. 1a.

an anion exchanger but the officials were evidently convinced that the chlorides would not be objectionable. The blended water is a marked improvement over the raw water and the local consumers are pleased with its quality.

The cost of the complete plant, including equipment erected, building and foundations, piping, etc., was approximately $75,000. This cost does not include the equipment which already existed, such as deep well pump, high-pressure pumps and chlorinators. The output capacity of the plant is 600,000 gpd. The actual operating cost is estimated and shown in Table 3.

TABLE 3

*Operating Cost of Plant "A"*

| | |
|---|---|
| Interest and Amortization | $ 7,100 |
| Maintenance and Supplies | 2,070 |
| Labor and Supervision | 11,700 |
| Power | 550 |
| Chemicals | 14,900 |
| Total Annual Cost | $36,320 |

Chemical costs, as given, are confined to 60° Bé $H_2SO_4$ which is obtained from one of the local fertilizer firms for $13 per ton delivered. On this basis the chemical cost of treatment is 6.8¢ per 1,000 gal. treated water output.

By actual test on plant scale, the exchanger material had a capacity of 11,850 gr. per cu.ft., as against 11,500 gr. as guaranteed.

## Salt Intrusion—Plant "B"

An interesting problem was recently presented for cost analysis where high salt content (sometimes exceeding 700 ppm. chloride) in the water supply was objectionable. This supply was taken from a number of wells distributed over a good sized area. Some of these wells were subjected to salt intrusion during high demand of water, and numerous complaints were registered from users. The problem was to de-ionize completely part of this water and blend it with raw water so that the chloride and hardness in the finished water would not exceed 250 ppm. Chemical analysis of one well and the treated water is given in Table 4.

TABLE 4

*Treatment of High Sodium Chloride Water—Plant "B"*

*(Results expressed in ppm. as $CaCO_3$)*

| | *Raw* | *Cation Effluent* | *Anion Degasified Effluent* | *Blended 48% Raw + 52% Treated* |
|---|---|---|---|---|
| Calcium | 315 | 9 | 9 | 156 |
| Magnesium | 124 | 4 | 4 | 62 |
| Sodium | 415 | 12 | 17 | 208 |
| Alkalinity | 63 | — | 5 | 32 |
| Acidity (Mineral) | — | 766 | — | — |
| Sulfates | 78 | 78 | 2 | 38 |
| Chlorides | 713 | 713 | 23 | 356 |

The output capacity of the treatment plant was specified as 900,000 gpd. As it was desired to reduce the chloride in the raw water from 505 to 250 ppm., 52 per cent of the water had to be completely de-ionized and blended with 48 per cent of the raw water to meet this requirement. The hardness in the raw water was also objectionable, but with this treatment it would have been reduced from 439 to 218 ppm., which was below the amount specified. The chloride reduction, therefore, controlled the treatment requirements.

A gravity plant to treat this water consisted of cation and anion exchanger cells with wood tanks, acid storage and dilute acid tanks, storage facilities and dilute soda ash tanks, degasifier and the necessary piping, valves, pumps and accessories. The existing method is to pump the water from the wells directly into the mains. Provisions had to be made to bring the well

water direct to the treatment plant. The water had to be pumped from the cation cells to the anion cells and again to the degasifier. After blending, the water was to be discharged into a new clear-water reservoir from which it was pumped into the mains. As against the present method of one pumping, this plant required three extra pumpings at relatively low heads. With a pressure system, only one extra pumping was required but pressure systems require steel exchanger cells which were not available under the priority regulations then in force.

The cost of this plant, with a capacity of 900,000 gpd. blended water, was estimated at $200,000, including building, equipment, pumps, piping, valves and accessories complete.

The estimated operating cost of this plant is given in Table 5. It will be noted that the chemical cost comprises over one-half of the annual operating cost. The cost per 1,000 gal. is 26.9¢ of which 11.5¢ is for chemicals.

TABLE 5

*Operating Cost of Plant "B"*

| | |
|---|---|
| Interest and Amortization | $19,850 |
| Maintenance and Supplies | 5,700 |
| Labor and Supervision | 12,600 |
| Power | 2,300 |
| Chemicals | 47,800 |
| Total Annual Cost | $88,250 |

Untreated water is now being sold in the community for $135 per mil.gal. and, as the treatment cost is estimated at $269 per mil.gal., the water supplier cannot afford to treat this water without a substantial increase in rates. The possibility of increasing the rates to meet the increase in treatment cost is, under present conditions, rather remote. The supplier is now looking for a new source of supply or may possibly obtain a suitable water by sinking more wells and reducing the draught on the wells.

## Complete De-Ionization

Complete de-ionization of water will produce a water practically equivalent to distilled water. Silica is not removed nor is it increased in the process. An effluent from this process is too good for a municipal supply and too costly. The finished water is highly corrosive and chemical adjustment would be required. This process is useful in the municipal field to remove excessive chlorides or sulfates where these salts are present in quantities to produce objectionable tastes or act as a purgative.

Complete de-ionization of part of the supply with blending with a portion of the raw water is applicable to municipal water supplies where a cheaper source of potable water is unavailable. In these cases this process is practicable and is the cheapest method known for reducing these ingredients.

The main application of complete de-ionized water is in the industrial fields where distilled water or its equivalent is required. The cost of de-ionized water is usually considerably cheaper than water produced by distillation. Figures given (4) for distillation are $2.00 to $8.00 per 1,000 gal. for single-effect evaporators and 60¢ to $1.00 for quadruple-effect evaporators.

Figure 2 gives the approximate chemical costs for complete de-ionization. Chemical costs vary directly with the ions removed. For a water with 100 ppm. of cations and 70 ppm. of anions, both expressed as $CaCO_3$, from the curves, the cost of chemicals is taken off as $22 per mg. or 2.2¢ per 1,000 gal. Similarly, with cations of 450 ppm. and anions of 280 ppm., the

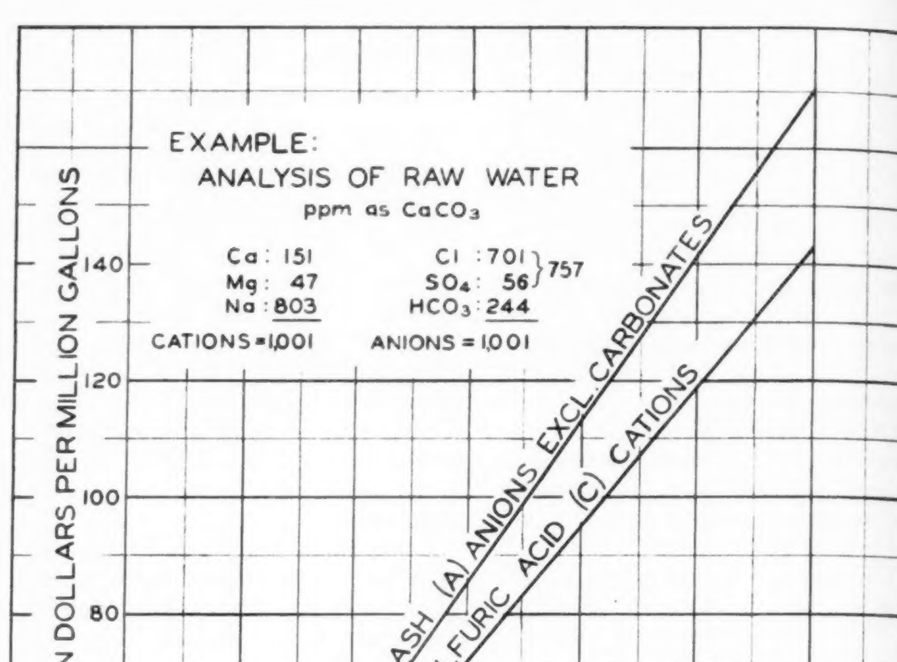


Fig. 2. Chemical Cost of De-Ionization

cost is \$93 per mg. or 9.3¢ per 1,000 gal.

The curves were prepared on the basis of most efficient regeneration, with a view of obtaining the maximum chemical savings for average and large size plants. They do not apply to the small plants where first cost is an important factor and operating costs can be sacrificed.

Chemical costs in preparing these curves were taken at \$20 per ton for 66° Bé $H_2SO_4$ and \$25 per ton for 98 per cent $Na_2CO_3$.

The acid requirements shown will vary somewhat with different waters, depending on the ratio of carbonates to total dissolved solids, i.e., the higher the carbonate ratio, the lower the acid requirements and vice versa.

## Summary

1. Complete de-ionization of water in the municipal water works field is limited to waters with high sodium bicarbonate, sulfate or chloride content. Even in these cases only part of the water usually requires this treatment with blending with the raw water.

2. This process is not intended to supplant the existing known methods of water treatment, as it is limited to special applications only in the municipal field.

3. Its application is unlimited in the industrial field of water purification where high-grade water is required for process, boiler feed and numerous other applications.

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# WPB ORDER P-43

**On July 22, 1944, Order P-43 (Safety and Technical Equipment) was amended. The amendment makes it possible for laboratories "to make experimental models of products designed for civilian markets" and "to get materials for non-experimental construction jobs (other than maintenance and repair) needed to carry on scientific or technological investigation, testing development or experimentation when the cost of the job does not exceed \$500" and apply the preference rating of AA-3 on such purchases.**

**This amended Order may be of value to large water works laboratories or testing units and should be studied by persons responsible for either.**

# Corrosion of Well Pumps

***By T. E. Larson and J. B. Millis***

SEVERAL years ago the Illinois State Water Survey conducted a corrosion survey by questionnaire among the municipal water superintendents throughout the state. The results of this survey indicated that approximately 40 per cent of the operators had a corrosion problem of one sort or another.

The questionnaire requested information on corrosion in mains, service lines, elevated tanks and pumping equipment. Analysis of the data with respect to the mains and service lines was subject to error due to variable flushing and was also complicated by the fact that on some occasions no distinction was made between corrosion and actual iron present in the raw water. Corrosion in elevated tanks was subject to the type and quality of the maintenance and no relative correlation could be made therefrom. Corrosion in pumping equipment, however, was roughly correlated with areas of high mineral content. This correlation was permissible since many of the external factors other than water quality were eliminated. It was noted, however, that within areas of waters of similar mineral content, wide variations in the extent of corrosion were reported.

In general, from this survey and from other observations made during the past 10 yr., nitrates in excess of 10 or 15 ppm. are excessively corrosive, particularly to copper and brass. Chloride concentrations in excess of 100 to 150 ppm. have been noted to cause corrosion frequently, and sulfates in concentrations greater than 200 to 300 ppm. have a similar effect.

Further inquiries on pump corrosion established the fact that no person or group of persons seemed to know the cause or causes for the highly erratic records on pump failures. Some attributed these failures to galvanic action, others to stray currents, some to water quality and still others to pump design.

The division often receives queries such as the following: How long will our pump be expected to last in this water? What kind of materials should be specified in ordering a new pump? How may I protect my pump from the corrosive action of the water? What causes the corrosion that seems to be taking place in my pump equipment? We reply that we don't know. We have asked the manufacturers and have learned after much conversation that they don't know. The owners don't know.

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A paper presented on April 11, 1944, at the Illinois Section Meeting, Peoria, Ill., by T. E. Larson, Chemist, and J. B. Millis, Asst. Engr., Illinois State Water Survey, Urbana, Ill.

For the past 4 or 5 mo. records on some 60 pumps in use by industries and municipalities in the Chicago area have been collected and attempts have been made to analyze these data to determine the correlation between the chemical quality of the water with the frequency and magnitude of replacements. Only in a general way have these data been informative.

Replacements on these pumps have varied from 0 to 50 per cent (of the total weight) of the pump and column pipe per year. In general, the greater the chloride and/or sulfate content of the water the greater the rate and cost of replacements. Wide discrepancies are still noted. These, in part, are due to the lack of complete and authentic records by the owners. Other reasons for these discrepancies are presumably related to the external factor of stray currents and to a large extent on the degree of maintenance and care given to the equipment. Some operators periodically remove their pump for inspection and repair; others leave the pump in place until the desired quantity of water is no longer obtained or until a breakdown occurs, even though they know that the pump is not producing at its maximum efficiency.

Some factors that contribute to the need for repairs are described as follows: A change in mineral content of the water. A well when new may produce water from one source, let us say the limestone which purposely or accidentally had not been cased out. After heavy use the well may produce the major portion of its water from the sandstones, which in some cases are of greater mineral content. This may increase the rate of corrosion. In another case the pumping level may be far below the crevice permitting limestone water to enter the well. As this limestone water enters the well and drops to the pumping level in the well, oxygen may be dissolved by the water. This may increase corrosion. A high $CO_2$ content is sometimes found to be present. The turbulence produced in the pump unit cannot help but produce $CO_2$ gas in vapor to cause serious corrosion at the relatively low-pressure points in this unit.

In another case a copper air line is used for the purpose of measuring water levels. This air line is in contact with the column pipe. Galvanic action takes place and corrosion is evidenced along the length of the column pipe in the proximity of the copper air line. There have even been instances where some very excellent copper wire has been used to bind the air line to the column pipe with the result that corrosion takes place around the circumference of the pipe at the points of contact with the copper wire.

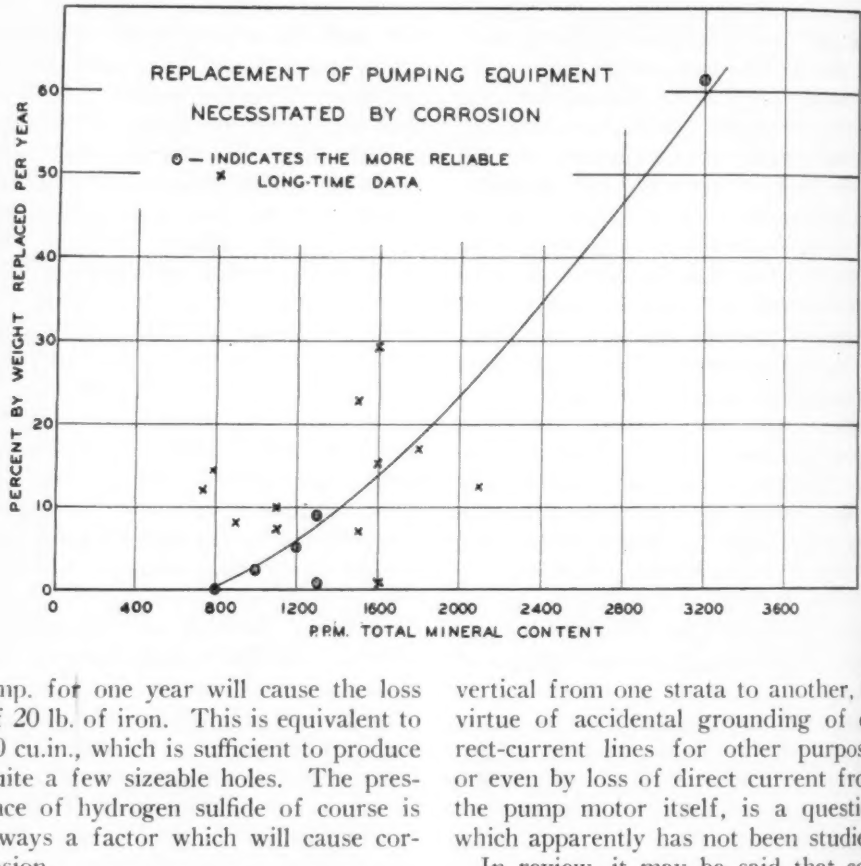
Galvanic action as a source of trouble cannot be stressed too much in view of the fact that most units use the standard design involving bronze impellers and cast-iron bowls. The galvanic corrosion does not ordinarily take place to a noticeable extent, but several factors may increase such action in some wells and not in others. One factor involves the question of whether physical contact between the dissimilar metals takes place and another involves the relative areas of the two metals exposed to the water. The latter factor is frequently overlooked. If the bronze area is small compared to the area of the steel or iron, little concentrated attack takes place. However, if the steel or iron area is small compared to the bronze, accelerated corrosion of the iron will take place, concentrated on the small iron area. The rate of such corrosion, of course,

is dependent on the conductivity of the water, which in turn is dependent on the total mineral content. The rate of flow of the water washing away the corrosion products is another factor to be considered.

No discussion will be presented here on theories of corrosion since no factual data are available. One item worth mention, however, is the theoretical assumption that the flow of 1 amp. for one year will cause the loss of 20 lb. of iron. This is equivalent to 70 cu.in., which is sufficient to produce quite a few sizeable holes. The presence of hydrogen sulfide of course is always a factor which will cause corrosion.

Besides such cases where the cause of corrosion is known, there are other instances where we can only note that something peculiar is taking place. One such instance of severe corrosion has been described as follows: On removal of the pumping unit the column pipe was so magnetized that a 6-in. wrench could be laid against the column and it would remain there as long as the bowls or suction pipe remained in the water. When the unit was raised above the water level this magnetism was no longer evidenced.

To what extent stray currents exist by nature in the earth, horizontal or vertical from one strata to another, by virtue of accidental grounding of direct-current lines for other purposes or even by loss of direct current from the pump motor itself, is a question which apparently has not been studied.




In review, it may be said that corrosion in well pumps may be caused by the very nature of the water in the well itself. It may be caused by unfortunate use of dissimilar materials in the wrong place. It may be caused

by actual electrolysis other than that produced by galvanic action. Naturally, a highly mineralized water will accelerate galvanic action or stray current electrolysis. The rate of pumping appears to be of no great significance. In general, because of the varied use of metals as well as the various mineral contents of the water, each pump installation must be considered as a separate study.

## Prevention of Corrosion

Among the methods noted to be in use for the prevention of corrosion are the following: In one specific unit the column pipe on the original installation had to be completely replaced at the end of 18 mo. of use. The replacement was coated with bitumastic paint and since that time bi-annual renewals of the coating have kept this unit in operation for 9 yr. However, on another installation bitumastic coating was effective for 5 yr. only before complete replacement was necessary. In other cases "No-oxide" or enamel is usually quite effective. Still other cases revert from the standard design in which bronze impellers in cast-iron bowls are used and specify instead cast iron throughout the unit with notable success. In other cases the use of cast-iron impellers has been found less effective than the use of bronze. Chemical action may nullify the advantage gained by eliminating the electrical effects of galvanic action. In many cases the bronze impellers and cast-iron bowls are used in conjunction with a stainless steel shaft and ordinary steel column pipe with no harmful effects. Such an array of dissimilar materials would ordinarily be expected to enhance corrosion, but apparently it has been found to be an effective preventive in these cases.

Plans for some installations involving insulation for the column pipe and discharge pipe from the pump motor and casing are under consideration. Some installations involve the use of non-conducting spiders for supporting the shaft protecting tube within the column pipe.

At the present time other units are installed with the attempt to apply cathodic protection, which has been so successful in elevated tanks. It is too early, however, to judge the general effectiveness of this application.

Another possible method for protection would involve the use of one of the polyphosphates in the well water itself during the periods of pumping. This method, of course, may be quite expensive, but for installations where pump replacements must be made semiannually the cost may not be prohibitive if effective at all.

It is not the purpose of this paper to discuss thoroughly the economics of pump maintenance, but it is felt that too often this item is neglected. When it is considered that the cost of the pump replacements is about $17 to $20 per 100 lb., and the cost of pulling the pump may often run as high as $500 or $600, the annual cost or cost per million gallons of water may be quite an item, to say nothing of the inconvenience or nuisance of having the pump out of operation for periods of several days to several weeks and the time and labor involved by the officials each time the unit is removed for replacements.

## Accurate Records Needed

It is hoped that in the future accurate records will be kept by the owners and manufacturers on replacements and repairs in order that actual data

be available for correlation. It is highly important to know of the actual metals used and the exact points of corrosive attack.

The Illinois State Water Survey has made several studies on the stray current electrolysis and further studies are planned for specific installations. It is hoped that these studies may yield some data whereby information can be given for pump materials and for protection of pumping equipment against corrosion by the water itself, as well as by electrolysis.

## *Discussion*

### R. E. Coughlan *

The corrosion of well pumps in railway water service is comparatively rare. Corrosion of pumping equipment including casings, drop pipes, etc., is sometimes encountered in deep wells, especially where carbon dioxide gas is present in the water or if any considerable amount of sulfates of soda and magnesia as well as chlorides of soda and magnesia are present.

It is extremely difficult to determine the actual cause of the corrosion of well pumps when encountered, inasmuch as the evidence is usually contradictory.

In railway water service very little research has been given to this problem by railway technical men.

A survey of the railways operating through the middle- and northwestern sections of the United States shows that during the past 20 yr. there were actually three cases of corrosion of well pumps. In one case the water had a high percentage of carbon dioxide, the second case was on a well of extremely high mineral content and the third case was that of a deep well furnishing water extremely high in sulfate of soda.

The railways in this district have never experienced a case of pump corrosion that could be traced directly to galvanic action or the presence of electric currents in the water.

The authors suggest the possibility of several methods which might help to solve the problem of corrosion of well pumps and, inasmuch as all research problems are seriously handicapped during the present emergency, it is to be hoped that future studies can be developed in line with the suggestions as offered in this paper.

### H. V. Bowlby †

The comments of Messrs. Larson and Millis are obviously preliminary due to lack of definite data on this subject, and it would be exceedingly constructive if it were possible for the Ilinois State Water Survey or some other organization to gather supporting information with reference to this subject, so that at some future time we could be better enlightened as to the problems of this subject.

It is the writer's belief that by far the majority of our corrosion troubles can be traced to electric action, either galvanic or resulting from stray ground currents. On many corrosion jobs we find the presence of electric currents either induced by galvanic action or the result of current flows at the well site from generating equipment in the vicinity of the well, or currents present from an unknown source.

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† Stannard Power Equipment Co., Chicago, Ill.

It is possible, theoretically, for galvanic action to set up current flows in the presence of highly mineralized water with certain types of pump construction, and if this happens there is the same type of corrosion as is the case with stray currents. The presence of electric currents induced by generating equipment is usually thought to originate from direct current, but there have been cases with current flow registering as much as 100 mv. at the well site with no direct current in the vicinity. In some cases we have found the presence of high-voltage alternating-current transmission lines within ½ mi. of the well site, but it is questionable whether this is the source of current at the well site or not. The question here is where does the current originate.

Other questions in the writer's mind are: (1) Why does the current in some wells flow from the well pump to a ground at ground surface and on others from the ground surface to the well pump? (2) Why is this current flow trouble becoming more evident in recent years in areas where heretofore no trouble existed?

The solution for operating a pump in the presence of these electric currents is still in an experimental stage. The writer has found the use of insulating materials to be of great help, as this breaks up the flow of currents, preventing the carrying away of the ferric oxides in the iron parts of the pump, and if this is done corrosion is arrested somewhat.

The use of stainless steel line shafting and all-bronze bowl assemblies, combined with bitumastic hot-spun processed coated column pipe, in addition to the insulation referred to above, are added assurances in overcoming this corrosion. As each installation has its particular problem with reference to first cost to equip a pump in this manner, however, a study must be made of this feature for a particular well before one would be justified in adopting it.

This subject is one that cannot be discussed to any definite conclusion with facts that are known today, as we are all experimenting more or less in the dark. It would be a great contribution to the pump owners if the necessary data could be assembled so that a solution could be made to this issue.

## R. H. Wasson ‡

Corrosion in most cases is the result evidenced by two general causes. The first would be the type of corrosion which is illustrated by dropping a piece of zinc, for example, in sulfuric acid. The acid attacks the zinc and ultimately destroys it. This is the type of corrosion generally experienced in handling acid mine and similar waters.

The second class is that referred to by the authors as electrochemical corrosion. Since most well pumps are subject to the latter type of corrosion remarks will be confined to that type.

It is probably natural that a chemist would look to a chemical method of solving this problem. It is just as natural that a manufacturer of equipment will try to determine what factors influence corrosion and then try to build equipment so as to minimize the destructive effects of corrosion, but rarely will a manufacturer attempt to recommend treatment of the water to eliminate corrosive effects. The writer's experience, therefore, in viewing the destructive effects of corrosion, is

‡ Manager, Pump Dept., Fairbanks, Morse & Co., Chicago, Ill.

gathered from cases where no water treatment to eliminate corrosive effects was encountered.

It has been found that the following factors affect corrosion in well pumps:

(1) The conductivity of the electrolyte affects corrosion. Those waters having a relatively high conductivity, in other words those waters which make a fairly good electrolyte, are found to promote corrosion. Waters of low conductivity retard corrosion.

(2) The condition of the surface of the metal in the pump. The result of corrosion is to coat the metal with the products thus formed. This coating tends to protect the surface against further corrosion. However, if this protective coating is removed, either by the erosion caused by the velocity of the water flowing through the pump, or by abrasion, the protective coating is removed and corrosion accelerated.

(3) The proximity of electrodes. In general, the closer together the electrodes, barring actual contact, the greater will be the corrosion.

(4) In general, a metal under stress is more readily corroded than an unstressed metal.

(5) The position of the various metals used in construction of the pump in the electrochemical series. Generally, the farther apart the metals in this series, the more rapid the corrosion.

(6) The relative area of the two different materials used in construction of the pump. For example, an all-bronze pump with a steel shaft would present a small surface of steel compared to the large surface of bronze. The steel would corrode very rapidly.

(7) The microscopic structure of the metal seems to be important. The finer grain, therefore less porous, metals seem to corrode less rapidly than the coarser grain metals.

Generally, the writer would recommend that the fewest possible kinds of metal be used, for example, the pump should be either all bronze, with a monel or stainless steel shaft, or all iron. Although the latter material would seem to be a solution, it should be remembered that cast iron, as a mechanical mixture of iron, carbon and other materials, is subject to galvanic action and the phenomenon generally called "graphitization" occurs. Iron subject to this type of corrosion gradually becomes lighter and less strong; the iron probably having changed to one of the hydroxides of iron. Therefore, the prevention of corrosion by the use of an all-iron pump is not always successful.

## Effective Coating

The next best selection would be an all-bronze pump using a monel metal shaft, for monel metal and bronze fall very close together in the electrochemical series. Monel is not readily available at the present time, however, so it will be necessary to use stainless steel, which is also close to the bronzes in the electrochemical series. The use of bronze for the column makes the pump too expensive and the cost cannot be justified by performance. The most practical solution found to date is the use of an all-bronze bowl section with steel column, taking a great deal of care to see that the column is carefully coated with a bitumastic paint. In other words, where the metal is to be bare, a metal that will not be likely to deteriorate by galvanic corrosion should be used and the other metals coated so that water cannot attack them.

## Frank P. Macdonald §

The authors clearly illustrate the importance of considering all factors involved in the corrosion of well pumps. The total mineral content is important and of at least equal significance are the dissolved $O_2$ concentration, Langelier saturation index, pH and other factors.

It is easy to observe the significance of the total mineral content upon the corrosion intensity since the resistivity is governed by the mineral content. The presence of depolarizers such as ferric ions and dissolved oxygen would reduce the cathodic polarization and increase the open circuit potential difference between the local anodes and cathodes.

An electrical explanation of the magnetization of the pump casing would be helpful, since the rotating pump shaft and impeller may be cutting magnetic lines of force and generate direct current.

### Example Cited

About three years ago, we applied cathodic protection to an oil-lubricated deep well turbine pump at Lapeer Mich., in co-operation with Mr. O. E. McQuire of the Sanitary Engineering Division of the Michigan Department of Health. This was an 8-in. pump with a 90-ft. setting and had a static level of 45 ft.

Accurate records of the percentage of metal lost each year are not available, but the entire column pipe below the static level had to be replaced frequently.

When the pump was pulled in May 1941, the steel column pipe showed large holes pitted through, throughout its entire length, with the loss of metal being concentrated below the static level, especially at threaded connections. The steel shaft housing was badly pitted although the loss of metal was not as extensive as in the column pipe.

### Protection System

New steel shaft enclosing pipe and steel column pipe was obtained and installed in the pump assembly. A cathodic protection system was designed for the prevention of the loss of metal as previously evidenced and the system was installed as the pump was inserted in the well. The pump was placed in operation on June 7, 1941, and direct current of 1.5 v. and 0.7 amp. was applied with the pump operating. With the pump off and water at static level, 0.5 amp. was applied. A study was made of the corrosion factors involved and the previous loss of metal to determine the current density necessary to prevent corrosion in this pump.

Operation was continued for 31 mo. until February 9, 1944, when the pump was pulled for inspection. Neither the shaft housing nor column pipe showed any evidence of corrosion. No scale or corrosion products were present and a slight calcium film had developed on the exterior surface of the shaft housing and the interior surface of the column pipe. There was no apparent pitting or etching of the steel and its appearance was the same as when installed new. The threaded connections were in perfect condition. The sacrificial stainless steel anode had lost some metal, but its appearance indicated it might have a useful life of an additional one or two years.

Cathodic protection of the shaft had not been provided for and some cor-

§ Electro Rust-Proofing Corp., Dayton, Ohio.

rosion of the shaft was evident. In the oil-lubricated type of pump, where the shaft enclosing pipe makes cathodic protection of the shaft impractical, it would appear advisable to use a stainless steel shaft.

Other applications of cathodic protection for deep well pumps have since been made for the prevention of corrosion in various parts of the pumps. This is, however, the first inspection after a reasonable operating period to determine the results obtained, and it is believed that the evidence warrants further applications of cathodic protection in well pumps.

It will be necessary to study each corrosion problem separately, based on the corrosion normally occurring in each pump, before cathodic protection can be properly designed and successfully applied.

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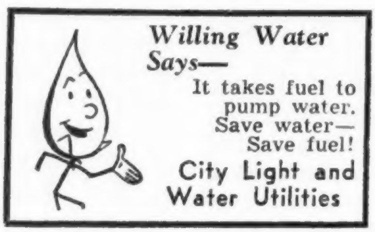
**To tell customers about water conservation, City Light & Water Utilities, Kalamazoo, Mich., uses Willing Water to put across the message in little space and few words. The small ad shown below is one of a series run in local papers every other week.**



# The Calculation of Alkalinities and Free Carbon Dioxide in Water by the Use of Nomographs

***By John F. Dye***

IT has long been recognized that the methods of calculating the three forms of alkalinity and the determination of free carbon dioxide as given in *Standard Methods* and other texts are not accurate. These methods still rely on analytical procedures, stoichiometric in character, originally developed for the testing of concentrated solutions. The only concession that has been made to the growing knowledge of the physical chemistry of dilute aqueous solutions has been the inclusion of the determination of the hydrogen-ion concentration, or, as later termed, the pH value of the water. Ever since the determination of the pH values of waters has become a recognized necessity water technologists have been assiduously determining and recording pH values *without,* except in the case of a few specialists, giving much thought to the real significance of the values they found, either alone or in conjunction with the alkalinity determinination.

However, physical chemists investigating the properties of dilute solutions of the weaker, very slightly ionized acids and their salts, especially carbonic acid, have supplied the necessary constants, and in 1936 Langelier (1) applied this knowledge to the problems of corrosion and scale formation and proposed his well-known ***saturation index*** as a yardstick in evaluating the corrosive or scale-forming properties of waters. In his paper Langelier also presented equations for computing the carbonate and bicarbonate content and suggested that similarly derived equations for carbonic acid and hydroxide alkalinity could well be included in *Standard Methods* to supplement the present discussion of alkalinity.

DeMartini (2), in his paper which indicated the practical value of the Langelier index, presented the equations for the computation of all four values, that is, free carbon dioxide and hydroxide, carbonate and bicarbonate alkalinities from the total alkalinity and pH value but still expressing the results in mols per liter. Moore (3), in his paper on the graphic determination of $CO_2$ and the three forms of alkalinity, presented the DeMartini equations in a much more practical form, in that the results were expressed in parts per million of $CO_2$ and of equivalent calcium carbonate in the case of the alkalinities. Graphs were given which eliminated the tedious work of solving these equations, but for use in water softening neither these graphs nor the triangular co-ordinate diagram

A paper presented on April 28, 1944, at the Michigan Section Meeting, Jackson, Mich., by John F. Dye, Chief Operator, Water Conditioning Plant, Board of Water and Electric Light Commissioners, Lansing, Mich.

in the *Manual of Recommended Water Sanitation Practice* * are satisfactory. Interpolation and/or extrapolation is difficult in either case, especially in the range of low alkalinities dealt with in water softening and it was for this reason that the alignment chart and nomographs presented here were developed.

The author believes we have all been guilty of testing the alkalinity of a water and getting a result of, for example, total or methyl orange alkalinity, 40 ppm.; phenolphthalein alkalinity, 20 ppm.; and assuming that only normal carbonate was present. At the same time we would determine the pH value of the same sample and obtain a result of 10.30, record it and let it go at that. After all we were using the best procedure of 25 yr. ago and furthermore *Standard Methods* said we were right. We did not realize that we were guilty of "double talk" and were making opposing statements.

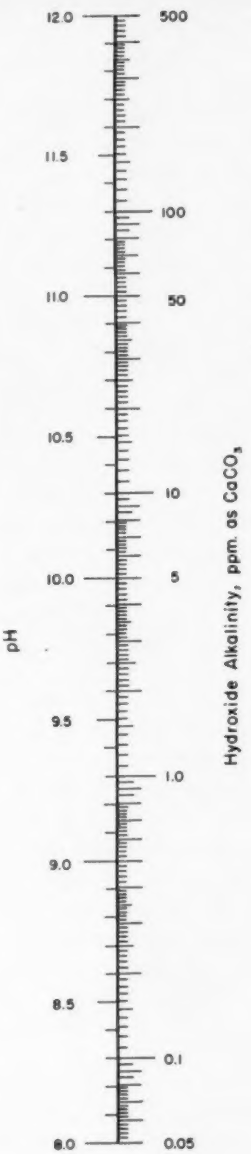
We knew that the ion product or $K_w$ for water was $1 \times 10^{-14}$ at 25°C., and that in determining the pH value we were also determining the pOH value, but few of us went to the trouble of actually calculating the pOH value, or, if out of curiosity we did so, we did not take the next step and convert to the equivalent hydroxide alkalinity, which in the above case is about 10 ppm.

Chart No. 1 gives in an easily readable form the value of the hydroxide alkalinities for the pH range of 8 to 12. It is strictly applicable only at a temperature of 25°C. A more involved chart is being constructed showing the hydroxide alkalinities for the various pH values over the range of temperatures usually encountered in municipal water softening. This chart will also be corrected for the total mineral content or ionic strength of waters, which of course affects the ionization constant.

It should be noted here that the hydroxide alkalinity found is limited by the total alkalinity and any pH values found which give values for the hydroxide alkalinity in excess of the total alkalinity are obviously in error.

To continue with the above case, if we have a total alkalinity of 40 ppm. and a hydroxide alkalinity of 10 ppm., we cannot have a normal carbonate alkalinity of 40 ppm. (according to the usual method of calculating this value from the phenolphthalein and methyl orange alkalinities), since it is obvious that the sum of the various kinds of alkalinity should not be greater than the total or methyl orange alkalinity. Suppose that the above solution, instead of being a sample taken in the plant, is a solution made up by dissolving 42.4 mg. of pure sodium carbonate in a liter of boiled distilled water so that the amount of normal carbonate which has been put in solution is known. This latter solution would give the same results on testing for phenolphthalein and methyl orange alkalinities and pH value as the plant sample, and since in this sample also the hydroxide alkalinity is about 10 ppm., it is evident that there was a reduction in the carbonate alkalinity when this normal carbonate was dissolved in water. An amount of carbonate equivalent to the hydroxide alkalinity, as determined from the pH value, cannot have simply vanished, so it would be logical to assume that it has taken on a new disguise and now exists as bicarbonate ion, $HCO_3^-$. In other words, to produce the hydroxide alkalinity found, an hydrolysis has taken place, the $CO_3^=$ ion combining

* Public Health Rpts. (Reprint No. 2440) **58**: 38 No. 3 (1943).




**Relation between pH and Hydroxide Alkalinity in Waters, (at 25° C.)**

$$OH^- \text{ (in terms of } CaCO_3) = \frac{5 \times 10^{-10}}{(H)}$$

Chart 1

with one hydrogen from a molecule of water to form $HCO_3^-$ and releasing one OH ion which appears then as hydroxide alkalinity. The result is the decrease in carbonate which was indicated above.

This chart shows very clearly that there is no critical pH value above which we have and below which we do not have hydroxide or so-called caustic alkalinity, as might be indicated by calculating the hydroxide from the familiar $2P - M$ relationship.

Chart No. 2 shows the carbonate alkalinities for various pH values in the range usually encountered in water softening. This chart also is accurate only at 25°C. For the case discussed above the normal carbonate alkalinity, as shown by this chart, is 20.75 ppm. The remainder of the alkalinity, as will be shown on the next chart, is the bicarbonate alkalinity of the sample. The slight discrepancy between the 10 ppm. OH alkalinity and the 9.25 ppm. of bicarbonate alkalinity may be due to errors in the constants used in the equations.

Although the full equations are given on the charts for carbonate and bicarbonate alkalinities exactly as Moore presented them, the hydrogen ion concentration is so small a value that addition was omitted in the numerator of the second term at high pH values. Only at a pH of 7 and lower is it of sufficient magnitude to affect the final values.

A study of this chart shows some interesting facts:

(1) For any total alkalinity found there is a maximum carbonate alkalinity which, for about 35 to 40 ppm. total alkalinity, is about one half of the total. As total alkalinities increase above 40 ppm. the percentage of carbonate alkalinity increases above 50

per cent and below 35 ppm. the percentage decreases below 50 per cent.

(2) The pH of maximum carbonate alkalinity is a function of the total and carbonate alkalinity, increasing as these values increase or decreasing as they decrease, instead of being a single value. At the Lansing, Mich., plant the pH of the first carbonation basin effluent (after excess lime treatment) which gave the maximum precipitation of calcium carbonate or the greatest decrease in alkalinity was from 10.3 to 10.4, with a total alkalinity of about 45. This differs from the pH value of from 9.3 to 9.4 commonly found in the literature as the pH of minimum solubility of calcium carbonate and mistakenly recommended as the pH value to which we should carbonate. This lower figure is true only after complete equilibrium has been reached and all excess calcium carbonate has precipitated—a condition almost never reached in plant operation.

(3) There are two pH values for each value of normal carbonate except at the pH of maximum carbonate alkalinity. This is of importance in water conditioning in the control of final alkalinity and pH by either over- or under-carbonating following excess lime treatment, and should have some application where split treatment is used. The pH can then be adjusted after filtration to obtain any desired saturation index or stability index.

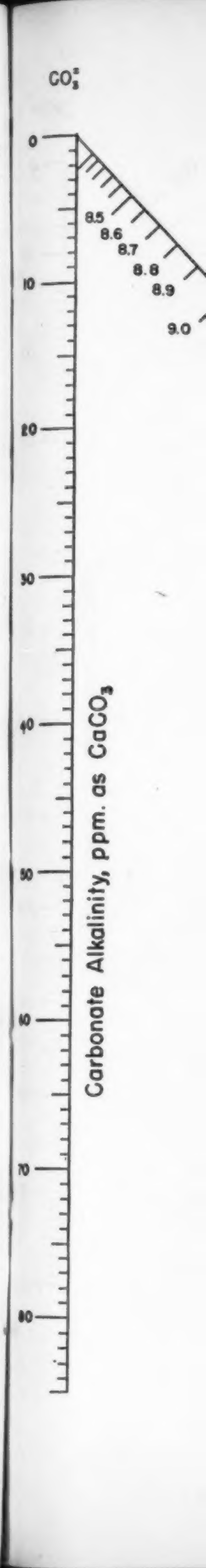
Chart No. 3 gives the value for bicarbonate alkalinities in the same range of pH values and total alkalinities as the previous chart. Perhaps it could better be combined with Chart No. 2, or it could be omitted entirely and the bicarbonate alkalinity found by difference, since the sum of the three kinds of alkalinity found on these charts always equals the total alkalinity.

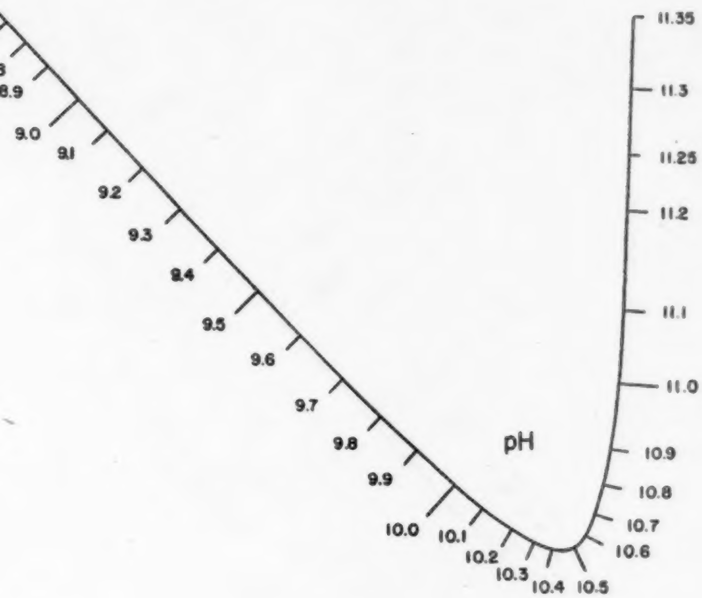
Chart No. 4 gives the value for the parts per million of free carbon dioxide corresponding to any ordinary pH value and alkalinity found in raw or softened water. The values found for the free carbon dioxide are slightly less than those found by Tillmans' formula (4), the difference increasing as the alkalinities increase and pH values decrease. The chart checks analytical results very closely if thymol blue, which has an end point pH of 8.5, is used instead of phenolphthalein as an indicator. That is, it will more correctly show the presence of free carborn dioxide at higher pH values than the usual methods.

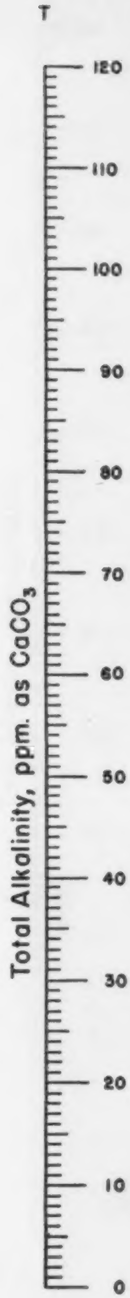
Chart No. 5 is a plot of the three kinds of alkalinity and free $CO_2$ in a water of 40 ppm. total alkalinity at various pH values. The sum of the values of the three kinds of alkalinity at any pH value will be the same as the total alkalinity.

It can be seen, according to Moore's equations, what physical chemists have long claimed is true, i.e., that neither bicarbonate and hydroxide alkalinity nor free carbon dioxide and normal carbonate alkalinity are incompatible. In fact, at one pH value all four can exist in the same solution.

Strictly speaking these nomographs and the equations from which they are derived are, according to Moore, valid only at room temperature or 25°C. and for total solid contents up to 500 ppm. However, except possibly for some surface waters in midsummer, the temperatures of waters in water softening plants are less than 25°C. (71°F.) and at higher pH values (above 10) a temperature correction should be applied to the ionization product for water and to the values for the hydrogen ion concentration in these equations. There is some evidence, according to Larson





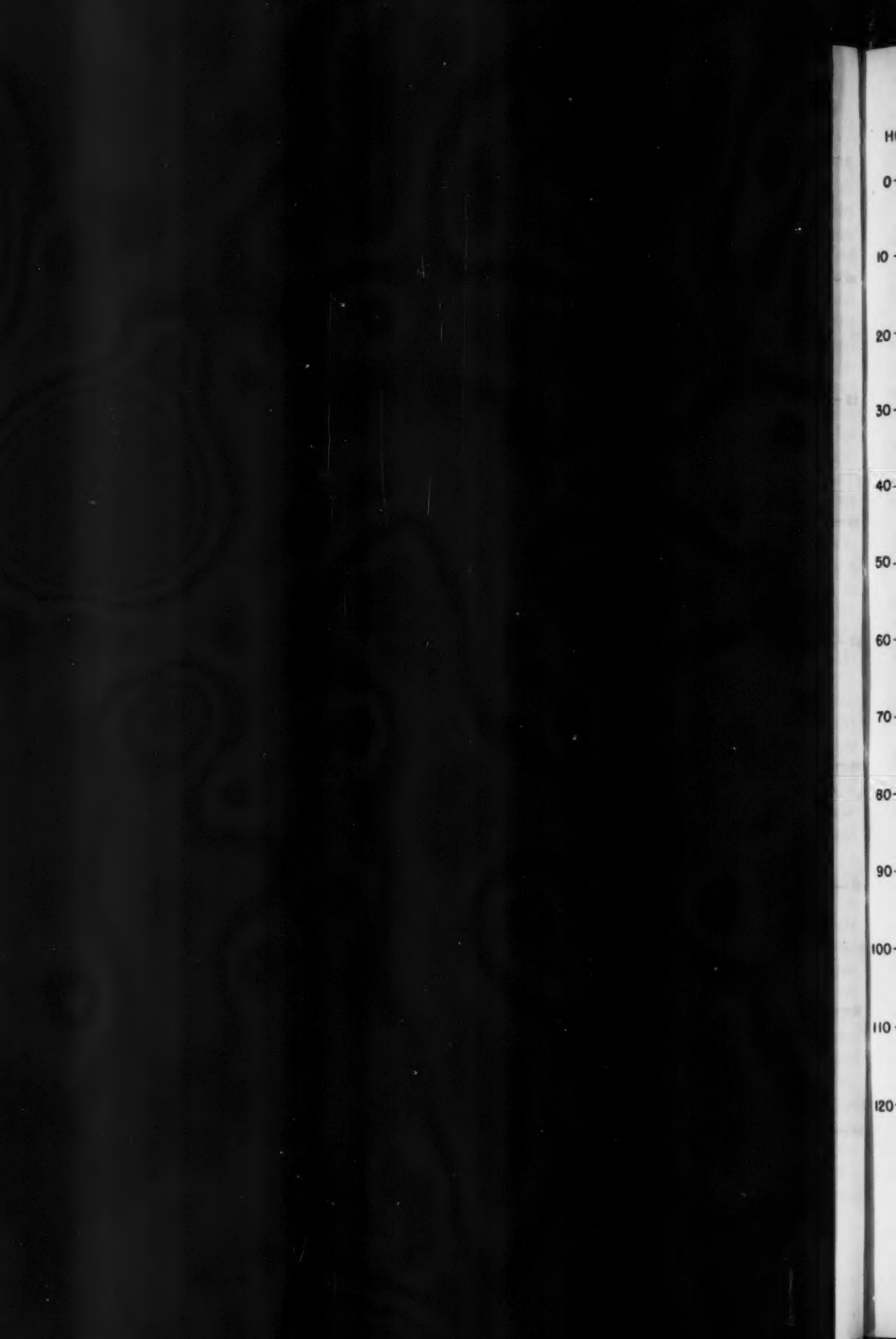




**Relation between pH, Total Alkalinity, and Carbonate Alkalinity in Waters,(at 25° C.)**

$$CO_3^{=}\text{(in terms of } CaCO_3) = \frac{5.61\times10^{-6}}{(\overset{+}{H})}\times\frac{\frac{T}{50{,}000}+(\overset{+}{H})-\frac{10^{-14}}{(\overset{+}{H})}}{1+\frac{11.22\times10^{-11}}{(\overset{+}{H})}}$$

Based on Moore's Equation: Jour. A.W.W.A., 31: 51 (1939).

Chart 2


0
10
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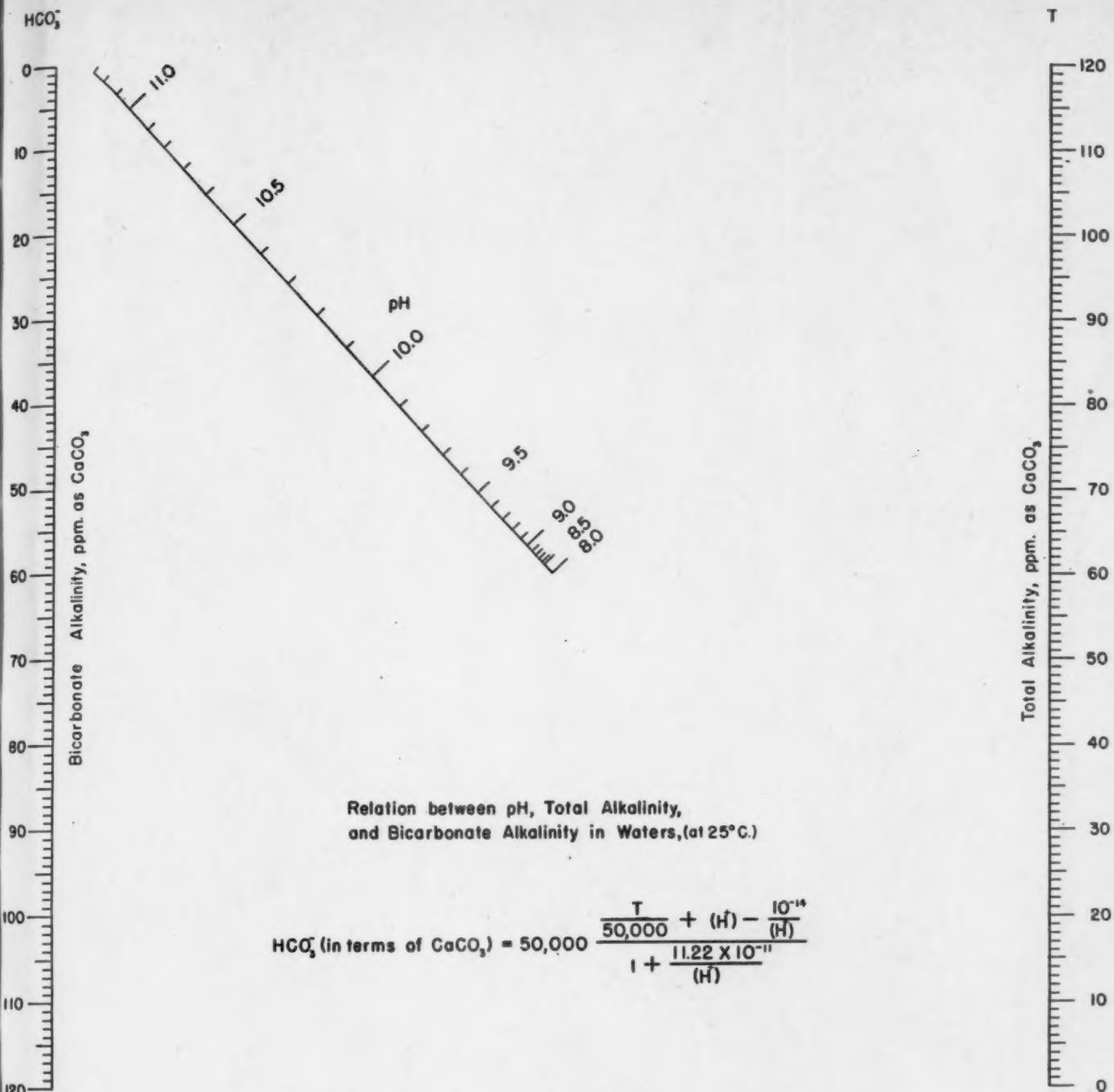
30
40
50
60
70
80
90
100
110
120

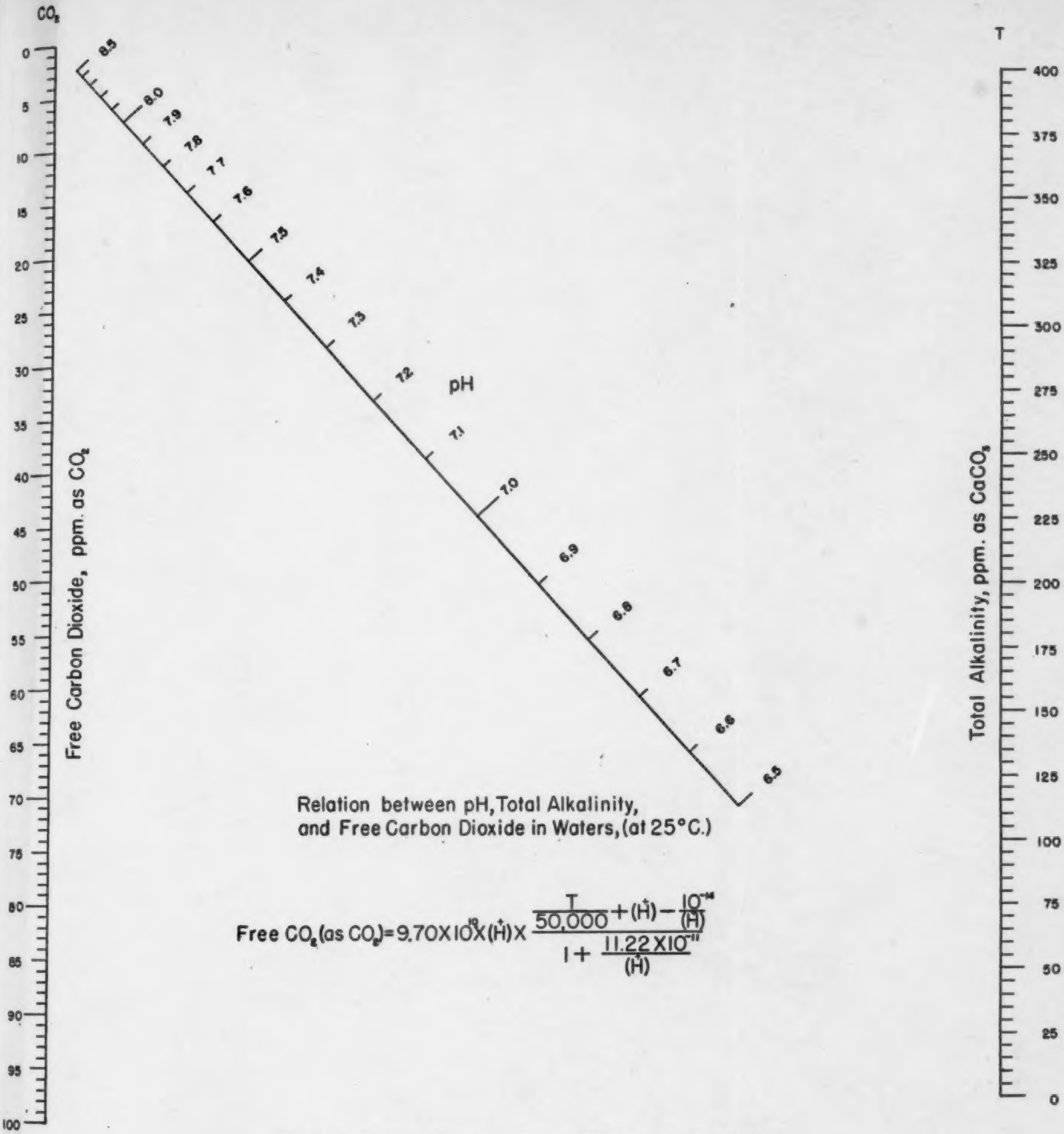



**Relation between pH, Total Alkalinity, and Bicarbonate Alkalinity in Waters, (at 25°C.)**

$$\text{HCO}_3^- \text{ (in terms of CaCO}_3\text{)} = 50{,}000\ \frac{\dfrac{T}{50{,}000} + (\text{H}^+) - \dfrac{10^{-14}}{(\text{H}^+)}}{1 + \dfrac{11.22 \times 10^{-11}}{(\text{H}^+)}}$$

Based on Moore's Equation: Jour. A.W.W.A., 31: 51 (1939).

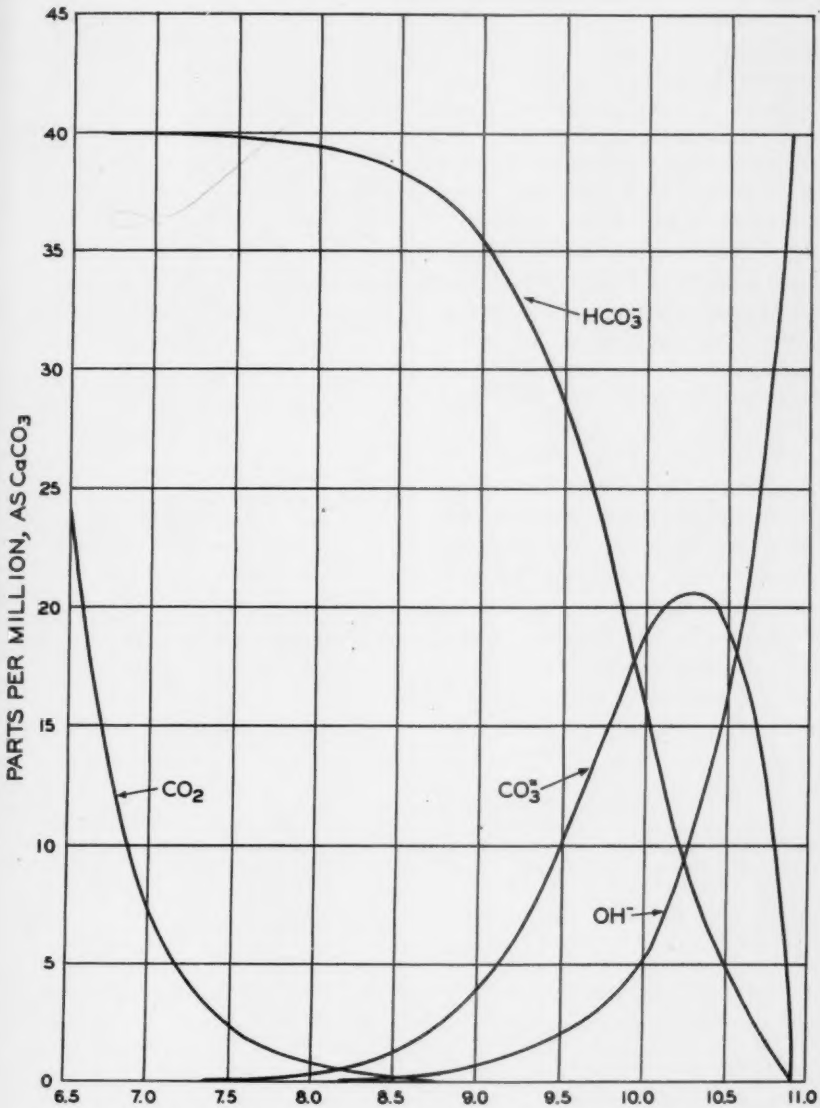
Chart 3




Based on Moore's Equation: Jour. A.W.W.A., **31**: 51 (1939).

Chart 4

*A*




APPLICATION OF MOORE'S EQUATIONS TO A WATER OF TOTAL ALKALINITY OF 40 P.P.M. TO SHOW THE CHANGES IN FREE $CO_2$ AND THE THREE KINDS OF ALKALINITIES WITH VARIATIONS IN pH VALUE, (AT 25°C.).

5

Chart 5

and Buswell (5), that still further corrections for ionic strength should be applied to the constants. These corrections would increase the free carbon dioxide values by about 1 ppm. in the usual range. The temperature correction is of much more importance.

These charts have been presented for two reasons: first, that they may help to dispel some of the older notions of alkalinity and pH relationships, and second, that they and similar charts may help the ordinary operator to a better understanding of pH-alkalinity relationships in connection with the problems of water softening, and perhaps explain some of the apparent anomolies that occur in treatment.

As Langelier, DeMartini, Moore and others have demonstrated, the free carbon dioxide content and the bicarbonate, carbonate and hydroxide alkalinities can be computed from the pH and total alkalinities of waters. These charts have been presented as a more rapid means of solving Moore's equations with the hope that they may prove more useful tools than the equations themselves or the diagrams, derived from these equations, that have so far been published.

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# The Effect of the Proposed New Jersey Ship Canal on Water Supplies

*By Charles H. Capen*

IT is a recognized fact that canals have played an important role in affording a cheap means of transportation and in the development of the natural resources of the nation. Prior to the era of huge expansion of railroad facilities, canals exerted a paramount influence on the lives of the citizens and the growth of communities. In the latter part of the last century, importance of inland waterways diminished correspondingly with the expansion of our railroad systems. In the present century, this condition has changed even more radically because of automotive transportation and more recently because of air transport, the effects of which may become even more pronounced after the war.

## General Plans for a Canal Across New Jersey

Development of a canal across New Jersey is not a new idea. It was first conceived at least a century and a half ago and came to fruition with the starting of the Delaware and Raritan Canal in 1830. A century later, use of this inland waterway had diminished to the point where it was no longer profitable to operate. Around the turn of the last century, many persons envisaged a much larger, speedier and more dependable canal. As a result, the river and harbor act of 1909 authorized a study of an intracoastal waterway from Boston, Mass., to Beaufort, N.C. So far as records available to the author are concerned, this was the first of a series of studies in which a canal across New Jersey has been an important item. In 1911, the New Jersey Legislature passed a resolution in favor of purchasing the land upon which such a canal could be constructed.

## Efforts Continuous

The Atlantic Deeper Waterways Association appears to have been formed about that same time and has been active ever since in the effort to obtain an island waterway along the entire eastern seaboard south from Boston. Because of combined efforts of this type, the stretch across New Jersey is now known as the "missing link" in the chain of waterways. It is not the purpose of the author to present the case for or against the canal in respect to its merits as a carrier. Rather, the ultimate effect of such a canal on the water supplies of the state is something in which all water works men may well take an interest and it is this aspect of the question on which this paper is based.

A paper presented May 11, 1944, at the New Jersey Section meeting, Newark, N.J., by Charles H. Capen, Chief Engr., North Jersey Dist. Water Supply Com., Wanaque, N.J.

### Type of Canal

The fundamental plan has been for a canal from Sayreville to Bordentown. Various minor changes in the route and lock details have been suggested from time to time. Originally two studies were made, one for a lock canal and one for a sea-level canal. The lock canal had two variations, one having a 12-ft. depth with a 90-ft. bottom width and the other having a 25-ft. depth and 125-ft. bottom width. The sea-level canal called for a 25-ft. depth and a 125-ft. bottom width. The early recommendation (in 1913) was for the construction of the 12-ft. depth lock canal with provisions for its subsequent change into a 25-ft. depth sea-level canal.

Since that time several additional studies have been made by the U.S. Engineer's Officer, including a comprehensive report, made about 1935 and reviewed in 1936. Depths of 25, 27 and 32 ft. were considered. The 27-ft. depth, with a bottom width of 250 ft., was finally recommended. The canal was to have a pool elevation 10 ft. above mean low water with locks at Sayreville and Bordentown. A dam would be constructed across the Raritan River at Sayreville, which would create a small lake at elevation 10, extending from Sayreville to a point above New Brunswick.

At the Bordentown end there was first proposed a dam across the Delaware River. This would have been expensive and would have disturbed a number of facilities along the river above the dam. Later a proposal was made to construct a small dam on Crosswicks Creek, between White Horse and Bordentown, so as to minimize the effect on the community.

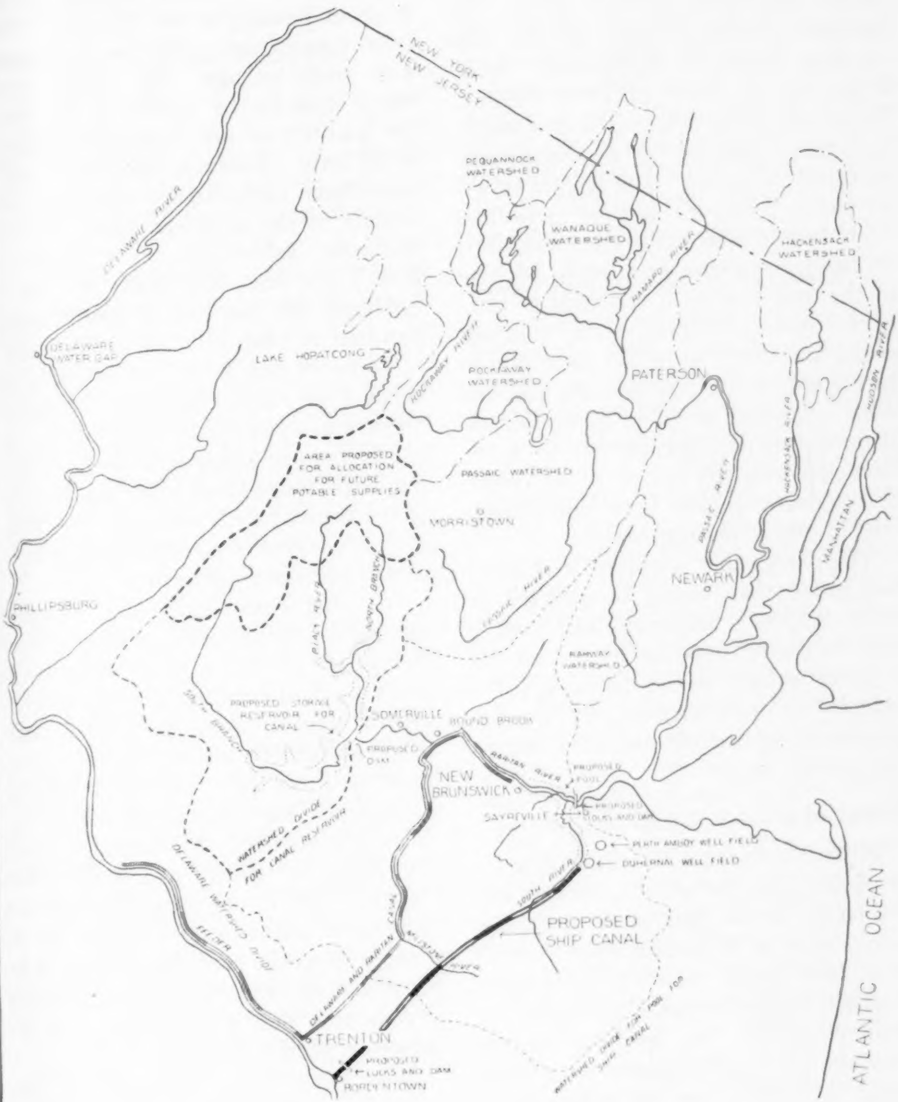
At one time the locks were to be arranged in two groups at each end, one group to have two large locks 90 ft. wide by 880 ft. long and two smaller locks 50 ft. wide by 370 ft. long. Other considerations have caused the revision of this arrangement and it is believed that some smaller locks may eventually be proposed in order to minimize the water requirements for locking small vessels in or out of the canal.

### Objections to a Sea-Level Canal

There arises the natural question as to why a truly sea-level canal should not be constructed; and to this there may be given the answer that a number of important factors are involved. One of these is the differential in tide level between Bordentown and Sayreville, both as to time and magnitude. The elevation of the Delaware River itself is an important item that would adversely affect operation. These differences would cause currents within the canal.

Another most important aspect is that of the salinity of the water. A sea-level canal would permit access of salt water to one of the most important water-bearing gravel outcrops in the state of New Jersey. It would also permit transmission of salt water into the Delaware River above the water supply intakes of Burlington on the New Jersey side and Philadelphia on the Pennsylvania side. It is believed that the quantity of salt so introduced would render the supply to those communities unusable for potable purposes. It would also adversely affect use of the Delaware River by the many industries located thereon.

By coincidence, the Raritan-Magothy formation, well known not only to geologists but to a great many water works men as well, traverses the state in almost precisely the same direction




PROPOSED SHIP CANAL AND WATER SUPPLIES IN NEW JERSEY

as the canal. In fact, a considerable portion of the canal would be located within this particular formation. A number of public water supplies are derived from this formation. Some large ones are those of Perth Amboy, Duhernal and Camden. The first would be directly affected by any salt water entering the strata. The second would be partly traversed by the canal and might be eliminated entirely. The third probably would not be affected because of the termination of the canal at Bordentown and the improbability that salt could traverse the strata laterally in such a manner as to reach the Camden wells. In any case, there is very strong argument against permitting salt water intrusion into the strata. This condition appears to have been well considered by the Army engineers.

There are other supplies of a lesser magnitude that would be affected or threatened by a sea-level canal, and to each of these, individually, the loss of a water supply would be as great a calamity as to the larger cities, the difference being merely one of quantity, rather than degree.

## Effect of a Lock Canal

With the decision to install locks, a decidedly different set of questions was involved. In the first place, the water would have to be predominantly fresh water and would therefore have to be obtained from streams available for such purposes. In addition to the quantity of water required to fill the canal basin, there are the quantities of water necessary to replenish losses from evaporation, leakage and, most important, lockage. Not only are the normal replacements for lockage necessary, but there are large extra quantities required for flushing. This flushing displaces salt water in or adjacent to the locks and prevents any excessive amounts of salt from entering the canal. Without flushing it was estimated that 1,000 tons of salt would be introduced with each lockage. By using fresh water equal to the volume of the lock, the quantity of salt would be reduced to 60 tons. Recently the Army engineers have authorized construction of models of the proposed locks (at the hydraulic laboratory at Vicksburg, Miss.) and have specifically set out to establish the quantity of fresh water required to keep salt out of the canal.

There would be little difficulty in keeping out salt if there were unlimited fresh water available. This, of course, would require either continuous flushing or prolonged and vigorous flushing at the time of each lockage. In either case it is necessary to find a means to obtain necessary quantities.

In canal construction the simplest method to provide fresh water is to intercept one or more large streams directly or to divert water from a large nearby stream. This particular canal is not favorably located for either of those two methods. The flow from a moderately sized watershed area, involving particularly the headwaters of the Millstone River, would be intercepted. This would provide a nominal amount of water in flood times, but in most seasons the contribution would be negligible, particularly since a minimum dry weather flow would have to be released to go downstream.

Most of the recent estimates of fresh water requirements for the canal envision a flow of 1,000 cu.ft. per second, i.e., 646 mgd., or just about twice the quantity of potable water now used in the entire industrial area of northeastern New Jersey. Within reasonable limits the quality of this water is not a too important factor, so that many

watershed areas could be used that would not be considered reasonable for potable purposes.

## Need of a Storage Reservoir

Early in the studies it became apparent that a large reservoir in the Raritan River basin would provide storage that could be used to augment the dry weather flow of the stream to such an extent as to supply a major portion of the water requirements of the canal. This was reported on in some detail by Congress in 1935. In the report it was proposed that a reservoir be constructed on the North Branch of the Raritan River, about $\frac{3}{4}$ mi. above the town of North Branch. The crest of the dam would be at elevation 125 (the elevation of the stream being 70). The area flooded would be about 9 sq. mi. and the storage capacity 130,000 acre-ft. or about 40,000 mil.gal.

Results of studies contained in this report showed clearly that the regulated flow of the Raritan River into the locks at Sayreville would not exceed 700 sec. ft. To make up this deficiency it was proposed to pump 200 sec. ft. from the Delaware River into the pool above the locks at Bordentown and allow this quantity to run out again into the Delaware River. While this would hardly cause a serious diversion, since it would remove the water at one point of the river and deliver it back again a short distance below, it was noted in the report that it might be necessary to take advantage of the water rights of the Delaware and Raritan Canal which were noted to be not far from the 200 sec. ft. required.

Obvious deficiencies of this plan made it desirable to review the entire study and in a later report the plan suggested called for a dam just below the junction of the North and South Branches of the Raritan River above Somerville. The capacity of this reservoir would be 218,000 acre-ft. at a flow line elevation of 105. The water surface area would be 17 sq.mi.

Various reviews of the situation show that even this increased capacity would not provide continuously more than 700 sec.ft. Some estimates show that as high as 875 sec.ft. would be needed for full-time operation.

## Effect of Canal on Watersheds

In order to appreciate fully the effect of the canal on the surface water supplies of northeastern New Jersey, it may be well to review the present uses. The bulk of water in this area is derived from surface sources. The largest users are as follows: (1) Hackensack Water Co., which obtains a supply from the Hackensack River and its tributary watershed; (2) Wanaque supply, operated by the North Jersey District Water Supply Commission for the several participating municipalities; (3) Pequannock supply of the city of Newark; (4) Rockaway supply of Jersey City; and (5) Passaic River supply of the Passaic Valley Water Commission.

The areas tributary to these several watersheds cover a large part of the section in question. Much of the balance is either low-lying territory, which is not adaptable to use because of location or elevation, or is so heavily populated that use of the runoff therefrom would be inadvisable.

At times all of the five large surface supplies mentioned above have been concerned with the question of meeting demands of the consumers. The Wanaque supply has frequently been drawn on for quantities exceeding the extreme dry weather yield. A succession of two or three dry years, such as

occurred a decade ago, would be likely to prove disastrous at the present rate of draft induced by feverish activities of the many war industries in the area.

The recent construction of some important interconnections between most of these supplies, as well as some others, has been of considerable potential value insofar as emergency needs are concerned. Time and experience have demonstrated that these cannot be relied on as an important factor for increasing the yield of the supplies collectively. Certain increases in storage on the large watersheds may be accomplished in the future, but it is believed that, in general, these increases will be merely sufficient to meet the demands of the immediate consumers and will not make large quantities of water available for other areas.

Various studies of the situation lead to the belief that Union, Middlesex and part of Somerset are the areas that are most likely to have residential growths coupled with a growth in industry. The territory along the Raritan River Valley is the section that seems most likely to require additional water. Potable and industrial uses of the valley are now about equal to the extreme dry weather flow of the stream. There are numerous indications that some of the industries located there cannot continue to expand unless additional water is soon made available.

The proposed ship canal would encroach on the use of the entire 158 sq. mi. of watershed in the Raritan River basin, which has been nominally considered as available for future water supply requirements. This area comprises about one third of the total area tributary to the reservoir that would be required for operation of the canal. If the canal and its reservoir were constructed prior to any use of the watershed for potable water supply, it is very unlikely that any diversions could be made without serious objections by the federal government. It must be noted, however, that serious consideration of use of the Raritan River watershed for potable purposes goes back as far as 1917 in specific printed reports on the project and probably much further in actual contemplation. While the canal reservoir on the North Branch may have been contemplated prior to that time, there is no material available to the author that would so indicate. The reports of the chief of engineers, published in the thirties, gave various data regarding such a reservoir, but so far as is known, did not specifically point out any necessity for allowing for diversions out of the watershed for water supply purposes.

### Recent Legislation

Early in 1944 the New Jersey Legislature passed a bill granting a sum of money to the Department of Conservation and Development for repairs to the Delaware and Raritan Canal, with power to contract for the sale of water from this waterway to industries located at points where such water could be used for commercial purposes. The bill has now become law. This may serve to alleviate the growing pains now being experienced in the Raritan River Valley. At the same time it may induce further industrial growth that will in time bring an attendant residential growth.

It is still believed by many, including the author, that a portion of the upper Raritan River watershed should be dedicated to potable water supply purposes, regardless of how far in the future its use may be required. To do this would require recognition of the case of the state of New Jersey by the

federal government, which was presented at a hearing before the Committee on Rivers and Harbors of the House of Representatives on March 9 to 12, 1943.

A report has been made to Governor Walter E. Edge, pointing out the possibilities of a water supply development on the upper branches of the Raritan River, and legislation has been prepared. Apparently, there was still some question as to the course to pursue in such a water project and the bill was not officially presented for consideration by the legislature. It seems possible that the problem will be studied further and that a bill may be offered at a later date.

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**In the July issue of this JOURNAL, reference was made (see p. 724) to the failure of water works executives as well as regional utility engineers to inform themselves adequately concerning certain sections of the U-1 Order. In the interest of brevity the words "regional engineer" were used in parts of the brief statement. By the term "regional engineer" was meant "regional utility engineer."**

**Under the terms of Order U-1, regional utility engineers maintain a list of available surplus material and water works executives are required to clear their needs for certain items through the regional utility engineer's office. This list will be found in Schedule D of Order U-1 and was published on page 249 of the February, 1944 issue of this JOURNAL.**

# Renegotiation of Water Bills by Federal Agencies

THE interest of federal agencies and the Congress in obtaining services and supplies for the military effort at a minimum cost to the government has led to the rapid development of a renegotiation aspect of war contract price procedures.

The 1944 tax law contains several paragraphs devoted to this subject. This JOURNAL is privileged to publish an analysis of the tax law prepared by Mr. John Murdoch, President of the Pennsylvania Water Works Association.

Pressure is being put on a great many water utilities, both public and private, for special discounts and special consideration on government contracts with the utilities. Insofar as renegotiation of water bills is concerned, that activity is covered by the terms of Mr. Murdoch's memorandum. Beyond the requirements for renegotiation, water departments or water companies are under no compulsion to give federal agencies special discounts or special consideration beyond the compulsions which derive from good business policy and an intelligent support of the war effort.

## *Memorandum Regarding Application of Renegotiation Act of 1943 To Contracts With Water Supply Agencies*

The Renegotiation Act of 1943 is Section 403 of the Sixth Supplemental National Defense Appropriation Act, 1942, approved April 28, 1942, as amended by Section 801 of the Revenue Act of 1942, approved October 21, 1942; by the Military Appropriation Act, 1944, approved July 1, 1943; by Public 149, 78th Congress, approved July 14, 1943; and as amended in full by Section 701(b) of the Revenue Act of 1943, enacted February 25, 1944.

The Act provides that certain contracts or subcontracts made with government departments, or with holders of contracts or subcontracts under such departments, may be renegotiated by the government so as to recapture for the use of the government excessive profits under the contracts.

### Meanings of "Contracts and "Subcontracts" as Applied to Water Supply Service

Certain contracts made with the following departments are subject to renegotiation:

- War Department
- Navy Department
- Treasury Department
- Maritime Commission
- War Shipping Administration
- Defense Plant Corporation
- Metals Reserve Company
- Defense Supplies Corporation
- Rubber Reserve Company

The act makes the term "department" mean the above-named departments, agencies or corporations.

The Renegotiation Act applies also to subcontracts and sub-subcontracts, but the subcontract provisions do not

appear to apply to contracts with a water supply agency for the furnishing of water service. The word "subcontracts" is defined in the act, Section 403(a)(5)(A) as follows:

Any purchase order or agreement to perform all or any part of the work, or to make or furnish any article, required for the performance of any other contract or subcontract, but such term does not include any purchase order or agreement to furnish office supplies.

Section 403(a)(6) defines "article" as follows:

The term "article" includes any material, part, assembly, machinery, equipment, or other personal property.

The provisions in regard to subcontracts are explained in the regulations reproduced in the *Federal Register* of June 7, 1944, page 6163, Section 1603.-333(d)(2). By this regulation it is provided that by the definition of "subcontract"

It is intended to exclude the sale of articles which contribute only indirectly to the actual manufacturing process, such as products used for general plant maintenance, including fuel and equipment to produce light, heat and general power requirements and such as equipment needed for general office maintenance including all types of office machinery and supplies, and such as safety equipment and clothing.

However, some water supply agencies may have contracts which would be considered subcontracts under Regulation 1603.333(b)(5), *Federal Register* June 7, 194/, page 6163. If the contract of the water supply agency is "for the performance of services directly required for the performance of contracts of subcontracts" for the processing of an end product or of an article incorporated in the end product which finds its way to a "department," such a contract would be under the Renegotiation Act.

Except as excluded by the act or the regulations, direct contracts with a department for water service are contracts to which the provisions of the act are applicable, but water service contracts with an original contractor, rather than with a "department" do not seem to be contracts to which the provisions of the act are applicable.

## Exclusions

Publicly-owned water supply agencies are not subject to the act as they are covered by a mandatory exclusion under Section 403(i)(1)(A). See *Federal Register* of June 7, 1944, page 6165, Section 1603.343(b)(1). The regulation reads as follows:

Under this provision of the Act no contract between one of the Departments and any other Federal, local or foreign Government agency is subject to renegotiation. A municipal corporation, whether acting in a proprietary or governmental capacity, is considered to be an agency of a State for the purposes of this exemption.

Paragraph (2) of the same regulation exempts such municipal corporations when acting as subcontractors.

There is an exclusion or exemption from renegotiation measured by the volume of business. Section 403(c)(6)(B) provides that:

This subsection shall be applicable to all contracts . . . to the extent of amounts received or accrued thereunder in any fiscal year ending after June 30, 1943, . . . unless . . . (B) the aggregate of the amounts received or accrued in such fiscal year by the contractor or subcontractor and all persons under the control of or controlling or under common control with the contractor or subcontractor, under contracts with the Departments, . . . do not exceed \$500,000. . . . If such fiscal year is a fractional part of twelve months, the \$500,000 amount . . . shall be reduced to the same fractional part thereof for the purposes of this paragraph.

This provision is explained in the

regulations in the *Federal Register* of June 7, 1944, page 6168, Section 1603.-348.

Under this section and the regulations, if the aggregate amounts received by a privately-owned water company and its affiliated interests under contracts with the departments amount in a fiscal year to more than $500,000, then all of the contracts may be renegotiated, but the aggregate receipts may not be reduced by refund below the exemption of $500,000.

### Financial Statements Required

A water supply agency, other than a publicly-owned agency, holding contracts with a department to which the provisions of the act are applicable, shall file financial statements in a form to be prescribed. This provision is set forth in Section 403(c)(5). No financial statement is required if the aggregate of the amounts received in the fiscal year by the water supply agency and its affiliated interests under department contracts amount to no more than $500,000.

The form of financial statement required from a utility is set forth in the Regulations in the *Federal Register* of June 7, 1944, page 6157, Section 1602.-222(4) as follows:

> Name and address of contractor.
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> Names of companies, if any, under the control of, or controlling, or under common control with the contractor.
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> Nature of principal business.
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> Date of expiration of fiscal year.
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> Balance Sheet, Profit and Loss Statement and Surplus Statement of the contractor for latest completed fiscal year.
>
> Declaration by the contractor that it will furnish such further and additional information as may be required by or on behalf of the War Contracts Board.
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> Such statement shall be executed on behalf of the contractor by his duly authorized representative and shall contain a certificate that the representations thereby submitted are true and correct to the best of his knowledge and belief.

It would seem that all privately owned water companies having direct contracts with the War Department, the Navy Department, the Treasury Department, the Maritime Commission, the War Shipping Administration, Defense Plant Corporation, Metals Reserve Company, Defense Supplies Corporation and Rubber Reserve Company should file the financial statements required by the Regulations, if the aggregate amounts received by the company and its affiliates amounted to more than $500,000. These financial statements are to be filed on or before the first day of the fourth month following the close of the fiscal year, or on or before the first day of the fourth month following the month in which the Revenue Act of 1943 was enacted. (February 25, 1944). The statements should be filed with the War Contracts Price Adjustment Board, Washington, D.C.

### Statute of Limitations

No proceedings to determine the amount of excessive profits shall be commenced more than one year after the close of the fiscal year in which received, or more than one year after the filing of the financial statement whichever is later.

# Abstracts of Water Works Literature

**Key:** In the reference to the publication in which the abstracted article appears, **34:** 412 (Mar. '42) indicates volume 34, page 412, issue dated March 1942. If the publication is paged by the issue, **34:** 3: 56 (Mar. '42) indicates volume 34, number 3, page 56, issue dated March 1942. Initials following an abstract indicate reproduction, by permission, from periodicals, as follows: *B.H.—Bulletin of Hygiene (British); C.A.—Chemical Abstracts; P.H.E.A.—Public Health Engineering Abstracts; W.P.R.—Water Pollution Research (British); I.M.—Institute of Metals (British).*

## WATER WORKS ANNUAL REPORTS

**13th Annual Report (For Year Ending December 31, 1942) of the Water Bureau, Metropolitan District, Hartford, Conn.** Dist. organized in '29 includes city of Hartford and towns of Bloomfield, Newington, Wethersfield, Windsor and East Hartford. Estd. pop. served 325,000. Consumption 29.125 mgd. or 89.6 gal. per capita. Gravity supply, cost of water per mil.gal. delivered, operation and maintenance $80.40; fixed charges $68.56—total $148.96. Distr. system of 587.47 mi. of 1 to 48″ mains serves 36,802 meters and 3812 hydrants. Distr. system extension of 27.5 mi. includes 17.5 mi. of 36″ and 48″ mains. 83 hydrants and 3137 meters added to system. Filtered and chlorinated water delivered has pH 6.5; hardness 12 ppm. Income: sale of water $1,569,124; other water revenue $18,924; other income $12,134—total $1,600,182. Expense operation and maintenance $554,413, depreciation $275,700, taxes $24,554, sinking fund $416,000, interest $308,110, miscellaneous $4,702. Total $1,583,479. $16,703 transferred to surplus. Fixed capital $29,349,896, bonded debt $11,569,000. Under Metropolitan District operation ('30–'42) plant value has increased 104.5%, revenue from sale of water 60%, operation expense 55.3%, consumption 56.3%, pop. supplied 53.3%, number of services 44.4%. Consumption of over 28 mgd. recorded on 166 days in '42 as against 32 days in '41. Max. rates of 45 mgd. prevailed, based on a 6-hr. period. About 93% of water filtered through slow sand filters and chlorinated at cost of $3.85 per mil.gal.; remainder of water chlorinated only. Dist. maintd. 27 rainfall and 7 stream-flow stations on watershed. Rainfall was 52.9″ or about 17% in excess of long-time avg. of 44.4″.—*O. R. Elting.*

**Annual Report (For Year Ending December 31, 1942), Medford (Mass.) Board of Water and Sewer Commissioners.** Estd. pop., 63,900. Avg. water consumption, 3.7 mgd. or 58 gpd. per capita. Operating income was $249,317.50; accounts receivable, $15,608.59; operating expense, $70,262.28; metropolitan water tax, bonds retired and interest on water debt, $195,745.16; expenditures from bond fund for water main constr., $38,255.06; balance in bond fund, $7,198.15. Distr. system consists of 114 mi. of 8, 6 and 4″ water mains with 1156 fire hydrants. In '42, 1569′ of new mains and 7 hydrants added. There are 11,068 services, 40 being added during yr. System 100% metered. Sewer extensions totaling 1682′ and costing $48,772.50 added to sewerage system, making total of 104.95 mi. There are 11,784 sewer connections, 43 being added during yr. at cost of $5,033.89. Operation and maint. of sewers, brooks and streams cost $7,460.68.—*O. R. Elting.*

**Annual Report (For Year Ending April 30, 1942) for the Water Department, Kansas City, Mo.** Estd. pop. served 400,000 within city and 75,000 outside. City distr. system of 873.95 mi. of 2 to 54″ pipe serves 88,136 services (94.8% metered) and 10,324 fire hydrants. Avg. amt. of water delivered to city 42.1 mgd. Treated Missouri R. water

delivered to system has hardness of 225 ppm. Water softening plant under constr. will reduce this to estd. 90 ppm. Improvement estd. to cost $900,000 will save consumers about $350,000 per yr. in cost of soap. Operating income $2,293,245, operating expense $996,999, depreciation $562,140, interest $513,598, miscellaneous $16,248. To surplus $204,260—total surplus $7,549,682. Operating expense includes $34,074 for civilian defense. Plant asset $27,770,440, less $7,317,440 depreciation. Net $20,453,010. Funded debt $14,067,000.—*O. R. Elting.*

**Milwaukee's Progress, 1942.** Report of all city activities prepd. by Municipal Reference Library. Water works operating revenues, $3,023,110, increase of $117,388 over '41. Net operating revenue over operation, maint., depreciation, interest and taxes equaled $665,830. $201,672 being reserved for bond redemption and $464,158 added to surplus. Value of plant $34,926,764; bonded debt $2,210,000; depreciation reserve $6,113,-124; city's proprietary interest $28,546,275. Water consumption 91.95 mgd. as against 89.67 mgd. for '41. Distr. system consists of 1007 mi. of 6 to 54″ mains serving 8608 hydrants and 97,955 meters. System 98.86% metered. Water main extensions only 766′ as compared with 11 mi. in '41. 387 services added during year. Per capita consumption, 137 gpd. for estd. pop. of 671,000.—*O. R. Elting.*

**30th Annual Report (For Year Ending June 30, 1943) of the Pasadena, Calif., Water Dept.** Estd. pop. 107,900. Water consumption 13.6 mgd. or 127 gal. per capita. WPB restrictions on materials and shortage of labor reduced new constr. to $47,661, smallest amt. in history of dept. Special rate for victory garden irrigation put into effect in '42 continued in '43. As of June 30, '43, 2761 applications for garden rates approved. This rate provides for 6″ per month at approx. one half domestic rate. Distr. system, consisting of 368 mi. of 2 to 36″ mains, serves 1749 hydrants and 29,982 services. 68% of water obtained from wells and remainder from Arroyo Seco and Eaton Canyons. Gross revenue $1,000,168, increase of $15,796 over '41–'42. Operating and maint. expenses $761,925, increase of $65,802, due principally to 39% increase in operation of pumping plants over previous years and maint. of guards on dept. properties. Fixed assets $8,308,882, depreciation reserve $3,-167,776, net $5,141,106. Bonded indebtedness $5,536,812. Prelim. plans for postwar constr. involving $674,000 expenditures for reservoir and water main constr. have been completed. Department organized in '12 by purchase of 3 water companies. Since then it has acquired 33 other systems.—*O. R. Elting.*

**Annual Report (For Year Ending December 31, 1943) of the Water Department of the City of Seattle, Wash.** Estd. pop. 575,000. Estd. consumption, 65.23 mgd. or 143 gal. per capita. Water mains 2 to 54″ in diameter total 1144 mi., serving 101,036 services (100% metered) and 10,354 hydrants. In '43, 11.73 mi. of mains, 73 hydrants and 2075 services added to system. Demand for water 19.4% over '42. Continued increase in demand will necessitate addnl. main from control works at Lake Young to the city. Supply and control work have capac. for 50% increase. Gross operating revenue $2,895,419; non-operating revenue $37,238; operating expense $725,093. Net income of $2,207,564, increase of $240,825 over '42, disposed of as follows: depreciation $619,896; interest on bonds $179,839; amortization of franchise and bond discounts $10,107; budget transfer by special ordinance $250,000; city occupational tax $87,567; sewerage service tax $576,000; general fund service tax $45,030; state utility and occupational tax $61,774. Total taxes $1,020,371, leaving net income of $377,352 added to surplus account totaling $12,328,651 at end of yr. Depreciated net value of resources $25,844,479. Outstanding bonds $4,145,000. Operating expense includes item of $100,000 placed in reserve for deferred maint. which could not be undertaken due to manpower shortage and material restrictions. Tap water: total hardness 22.7 ppm., pH 7.1, Cl 2.0 ppm. Cost of water delivered $0.0805 per 100 cu.ft.—*O. R. Elting.*

**Annual Report (For Year Ending December 31, 1943), Denver (Colo.) Board of Water Commissioners.** Board organized in '18 comprised of 5 men. Water consumption avgd. 77.84 mgd. or 191 gpd. for each of 407,000 citizens. Yearly, monthly and daily avgs. exceeded all previous records. Max. day 168.74 mil.gal. Yearly avg. for '41, 60.33 mgd. Plant able to keep pace with rapidly growing community and has made it possible to supply army camps, war industries

and about 8000 victory gardens without interruption to regular service. Board authorized use of water for vacant lot victory garden on basis of $1.00 for a lot 25′ × 150′ or smaller, instead of usual $4.40. City Council assumed payment of $1.00 out of General Revenue. Reduced water rates effective Apr. 1, '43, will save consumers $180,000 annually. Income for '43, $3,288,-993; disbursement, operation and maint., $965,024 (29.3%); depreciation, $607,370 (18.5%); capital expense, $1,563,028 (47.5%); invested capital, $153,871 (4.7%). Value of plant, $43,800,305; capital liabilities, $23,677,600. Cost per mil.gal. delivered (including 4% interest on investment), $115.87. Total service tops 81,202 active meters 3014 meter revenue 29.8% of total. 398 services added in '43 as against 2732 in '41 and 950 in '42. System consists of 115 mi. of 12 to 84″ conduits and 825 mi. of 1′ to 48″ mains in distr. system, 14 mi. of which outside city limits. Main constr. in '43 0.8 mi. Avg. analysis: *South Platte Source*, total hardness 109 ppm., pH 7.5, temp. 14.2°C.; *Moffat Diversion Source* total hardness 49 ppm., pH 7.4, temp. 8.9°C. Source of supply for city consumption: S. Platte River 49%, Fraser River 29%, storage 15%, Cherry and Bear Creeks 7%.—*O. R. Elting.*

**Greenville (S.C.) City Water Works. Auditor's Report (For Year Ending July 31, 1943).** Net profit from operation, $179,073. This compares with $161,089 for '42 and $143,437 for '41. Of this sum $100,000 applied to capital charges and $17,938 to addns. to plant. Value of plant and equip., $5,080,-847. Total assets, $7,256,466. Surplus (excess assets over liabilities) $1,658,614.—*O. R. Elting.*

**86th Annual Report (For Year Ending December 31, 1943), Louisville (Ky.) Water Co.** Revenues and net earnings for year were highest in records. In general, costs held to same amt. as in '42. Revenues were $2,544,178, increase of $186,823 over '42. Net profit for year equaled $1,350,304, increase of $177,985. During '43, $1,250,000 in dividends paid to Sinking Fund Board. Bonded indebtedness of $1,000,000 offset by sinking-fund reserve of $872,548. Cash reserve fund of $1,000,000 in govt. securities earmarked for expansion and improvements. Report of Alvord, Burdick & Howson sets forth projects totaling $4,400,000; $1,900,000 of this constr. to be completed before '50. Fixed capital valued at $21,847,373. Pop. of city and county estd. at 375,000. Original constr. in '80. System owned by city and managed by Board of Water Works. Source of supply Ohio R. Water pumped to reservoir and repumped to system 54 mgd., increase of 5.66 mgd. over '42. Pumpage exceeds 70 mgd. for 3 consecutive days. Max. consumption was 105.7 mgd. on evening of Aug. 24. Diminished ground-water levels noted for several yr. became almost major catastrophe during yr. Many war industries using immense quants. of ground water confronted with total failure of supply. Company able to meet extra demand with no reduction in high std. of service or quant. of water. Recommended that those industries use city water in cooler months, reserving underground reservoirs of cool water for summer use. Water Co. inaugurated plan of rebating 50% of price of water to some 6000 victory gardeners. Consumers increase, 1114; 839 new installations and 275 unused services reconnected. Active services totaling 75,597 are 100% metered. Distr. system totals 736.67 mi.; 5.65 mi. added during yr. Cost of pumping of Riverside Station (elec. pumping with steam standby) $4.1615 per mil.gal. or $3.185 per mil.gal. raised 100′, compared with $6.163 and $3.134 for '42. Crescent Hill Station, $6.16115 per mil.gal. and $4.750 per mil.gal. raised 100′, compared to $6.4691 and $4.713, resp., for '42. Total cost of purif., $6.008 per mil.gal. divided: supervision, $0.512; operating labor, $1.384; chems., $2.537; wash water, $0.513; heat, light and power, $0.313; supplies, $0.130; maint., $0.619. Avg. length filter runs: East Filters, 37.87 hr.; South Filters, 35.08 hr.; North Filters not operated. Wash water equaled 2.66% of total filtered. Avg. chem. dosage in gpg. filtered: alum, 0.90; pebble lime, 0.350; in lb. per mil.gal. filtered: Cl, 13.35; ammonium sulfate, 4.12; activated carbon (intermittent use only), 19.75. Detns. for (1) 37°C. count, (2) coliform organisms per 100 ml., (3) turbidity and (4) alky., avgd: *river water* (1) 4014, (2) 3249, (3) 150, (4) 58; *settled water* (1) 2992, (2) 1649, (3) 88, (4) 56; *coagulated water* (1) 1193, (2) 93, (3) 12, (4) 50; *filtered water* (1) 1.63, (2) 0, (3) 0, (4) 58. Total hardness 127 ppm.; pH 8.2; total solids 260 ppm.; Cl 31.—*O. R. Elting.*

**34th Annual Report (1943) of Oak Park (Ill.) Water Department.** Water secured on

metered basis from city of Chicago. Estd. pop. 69,000; daily consumption 5.303 mil.gal. or 27.3 gal. per capita. 107.4 mi. of mains supply 12,011 meters and 1135 hydrants. 9 services added in '43. System 100% metered. Water sold 89.5% of total. Total income $408,509. Expense: purchase of water $142,702; operation and maint. $76,783; interest $2,905; depreciation, $37,100; total $259,490 transferred to police and fire funds $160,419, net loss $11,400. Fixed assets original $1,264,473; less depreciation $322,656. Liabilities, bonds and deposit funds $93,765. Net worth (excess of assets over liabilities) $483,752.—*O. R. Elting.*

**Annual Report (For the Year Ending December 31, 1943), Des Moines (Iowa) Water Works.** Operated by 5-man Bd. of Trustees. Pop., 178,406; water consumption, 16.987 mgd. or 95.2 gpd. per capita—increase of 9.7% over '42. Metered water is 88.6% of water pumped. Distr. system contains 427 mi. of 4" to 36" water mains and 3665 fire hydrants. No fire hydrants added during year and water main extensions totaled 0.18 mi. 38,981 active services—increase of 157 for the year. Gross income was $1,032,401.31—increase of 6.58% over '42, while operating costs, exclusive of fixed charges and depreciation, were $395,380.74—decrease of 3.52% from '42. These operating costs were $2.22 per capita, $924.40 per mi. of pipe, $10.14 per service, $63.77 per mil.gal. pumped and 38.30% of gross income. Interest paid was 16.99% of gross income. Book valuation of fixed assets as of Dec. 31, '43 was $7,191,349.82, with bonded indebtedness of $3,506,000. Invested capital acct. increased $202,625.45, 19.63% of operating revenue. Pumping station output avgd. 16.97 mgd., max. of 29.1 mgd. and min. of 6.7 mgd. Avg. head was 280.3'. Coal burned per 1000 gal. of water pumped avgd. 3.42 lb. corrected for steam used in heating. Boiler and stoker efficiency, 67.7%. Coal analyses as fired: moisture, 19.95%; ash, 14.52%; Btu. per lb., 9.425. Total hardness of water, 357 ppm.; pH, 6.95.—*O. R. Elting.*

**Annual Report (For the Year Ending December 31, 1943), Elmira (N.Y.) Water Board.** Bd. organized in '15 comprised of 5 taxpayers, one elected each year for period of 5 yr. One commissioner has served since '19 and one since '28. Pop. of 66,000 consumed 6.34 mgd.—increase of 1.12 mgd. over '40. Believed that peak demand has passed. Consumption during last 6 mo. decreased, thus offsetting increase during first 6 mo. Decrease resulted in part from water conservation policy introduced by board as part of national program for conservation of natural resources. About 3 mi. of water mains and 19 hydrants added to system, making a total of 165 mi. of mains and 816 hydrants. There are now 14,941 connections to system, 435 being added during year. This number exceeded only in '16 and '25. System 100% metered. Cleaning of 16" main from Hoffman Creek Reservoir to filtration plant increased its capac. from 6.3 to 8.2 mgd. Operating revenue was $305,184.15 with operating expenses, including depreciation of $194,863.07, leaving an operating income of $110,321.08. Non-operating income was $2,303.80 and income deductions for interest on bonds and consumers deposits were $7,128.37. After paying $60,000 for bond retirement, net income of $45,496.51 resulted from year's operation. Plant and equip. valued at $2,715,004.13, with bonded indebtedness of $120,000. Balance sheet indicates city's equity as $2,265,349.95; also contains special fund of $30,044 for postwar constr.—*O. R. Elting.*

**Annual Report (For Year Ending April 12, 1943) of the Water Division, St. Louis, Mo.** Water Works acquired in 1835. Pop. of 814,717; daily consumption 139.4 mil.gal. or 171 gal. per capita. Distr. system of 1.257 mi. serves 156,032 services (8.88% metered) and 15,197 public and private fire hydrants. 475 services and 35 hydrants added during yr. Total hardness of water 99 ppm. Gross revenue from sale of water $4,149,769, less $56,437 commission paid collector. Net revenue $4,093,332. Operation and maint. $2,036,181. Excess of total receipts over total expenditures was $928,350. Cost of plant $52,451,320. Bonds outstanding $2,926,000. Cost per mil.gal. consumed $65.18. Revenue $80.44 per mil.gal. Highest stage of Missouri R. on record since Howard Bend Plant has been in operation occurred June 28, '42 with gage reading of 42.95 but 2.2 below door sills of engine room and boiler house. Study being made of necessary plant protection and provision for washing filters during periods of high water. Suspended matter and dissolved matter and chems. removed from river water avgd. 995 tons daily. Wartime protection of Water Division property cost

\$46,616. Water Division stored over 10,000 tons of old tires and scrap rubber for Rubber Reserve Corp. Cost of this work was \$69,040 for which Division reimbursed. Leaks developed in first 60″ steel conduit between Howard Bend and city required 129 plates to be welded onto conduit and 1926 pits filled by welding at cost of \$10,310.—*O. R. Elting.*

**Ninth Biennial Report, Board of Water Supply, City and County of Honolulu, 1941–42.** War caused greatly augmented demands on system; because of preparedness, however, possible to continue adequate and satisfactory service. Situation aggravated by drought; water use reached peak of more than 10 mgd. in excess of what considered safe withdrawal from artesian areas within Dist. of Honolulu. Dept. now proceeding with N. Halowa Project in which addnl. artesian water will be brought to system from a 284′ −30° inclined shaft and electrically operated underground pumping station in N. Halowa Valley. Laying of 4 mi. of 42″ and 36″ mains required; installation provides for two 5-mgd. pumps with later addn. of 10 mgd. unit. Estd. cost 1.5 million dollars. War protection precautions for plant and system, begun 17 yr. ago, consisted of decentralization of pumping stations; operation by steam for independence of centralized elec. energy; bldgs. constructed of heavy reinforced concrete; and installation of valves to provide continuous service. Plants now also guarded by Army. In prepg. for present war, trucks equipped with radios, some with two-way sets; employees given identification tags, immunized against typhoid and smallpox; underground control center built, in which at least one executive sleeps every night; center large enough to house employees and consists of 10 tunnels. Only 4 breaks occurred in Dec. 7 attack, consisting of 6″ main broken as result of water hammer caused by too rapid closing of fire hydrants at school on which direct hit made; another 6″ main from same cause; direct hit of $1\frac{1}{4}''$ service by either bomb or anti-aircraft shell; and $\frac{3}{4}''$ service break from same cause. Pop. of territory estd. at 210,000, of which 205,000 served. Vital statistics for 2 yr. as follows:

| *Item* | *'41* | *'42* |
|---|---|---|
| Total consumption, *mil.gal.* | 9643 | 9779 |
| Passed through meters, *mil.gal.* | 8660 | 8853 |
| Avg. consumption, *mgd.* | 26.4 | 26.8 |
| Avg. consumption, *gpd. per capita* | 132 | 128 |
| Avg. consumption per service, *gal.* | 1039 | 1046 |
| Cost of water per mil.gal: | | |
| Based on total maint., *dollars* | 67.77 | 70.59 |
| Based on total maint. plus fixed charges, *dollars* | 125.80 | 124.13 |
| Total pipe in system, *mi.* | 326.1 | 327.07 |
| Extensions, *ft.* | 22,620 | 6525 |
| Repair cost per mi. of main, *dollars* | 15.55 | 15.37 |
| Leaks per mi. of main | 0.23 | 0.15 |
| No. of hydrants | 2155 | 2166 |
| No. of services added | 1482 | 362 |
| Total services in system | 25,436 | 25,615 |
| Meters added | 1482 | 185 |
| Total meters in system | 25,413 | 25,598 |
| Percentage of system metered | 99.91 | 99.93 |
| Meters tested: | | |
| Old | 5292 | 3971 |
| New | 1596 | 77 |
| Meters repaired | 4065 | 3164 |
| No. bact. samples | 1185 | 4601 |
| Avg. plate count | 10.83 | 12.77 |
| No. of 10-ml. portions | 3059 | 9840 |
| Percentage positive for coliform organisms | 2.61 | 6.50 |
| No. chem. anals. | 2544 | 2638 |

87% of water comes from artesian wells, 13% from springs and tunnels, latter all gravity. Pressure range in system, 55–175 lb. Water has alky. of 52–69 ppm., total hardness of 37–205 ppm., total solids of 190–655 ppm.; pH of 7.5–8.2. Max. daily pumpage occured on Aug. 1, '41, and equalled 33.7 mil. gal.; min. day on day after Pearl Harbor, Dec. 8, '41, equalled 15.5 mil.gal. Total receipts for '41, \$1,590,310; for '42, \$1,599,138. Balance sheet shows assets of \$11,673,528 of which \$7, 915,613 net cost of utility, with accumulated depreciation of \$4,086,802. Initial cost, \$12,002,415. Total operating expenses in '41, \$653,532; for '42, \$690,343. Detailed data given of trouble found in meters. Reports contain informative graphs and illustrative photos showing some structures and underground shelter.—*Martin E. Flentje.*

**Annual Report, Chatham, Ont., 1943.** Anon. W.W. Inf. Exch.—Can. Sec. A.W.W.A. **5**: E: 27: 48 (Feb. '44). Pop. 22,000. Max. consumption 3.5 mgd. (U.S.) and avg.

2.59 mgd. or 118 gal. per capita. Total cost 8.38¢ per 1000 gal. Revenue $102,193.68—$30,950.35 in excess of expenses. Chem. dosages: Cl (pre- and post-chlorination) 13.3 and ammonium sulfate 3.9 lb. per mil. gal.; alum 1.6 gpg. Max. turbidity of river water 1200 ppm. Pressure: domestic 60, fire service 100 psi.—*R. E. Thompson.*

**Annual Report, Dorval, Que., 1943.** ANON. W.W. Inf. Exch.—Can. Sec. A.W.W.A. **5**: E: 26: 46 (Feb. '44). Rapid sand filter plant consists of 2 coagulation basins, providing 2 hr. 40 min. nominal retention, and 4 filters, 2 with sand as filtering medium and 2 with anthrafilt. Avg. turbidity of raw water 25 ppm. and avg. color 50 ppm. Latter reduced to 7 ppm. Max. daily consumption 0.95 mil.gal. (U.S.) and avg. 0.59 mil.gal. or 183 gal. per capita. Filter runs 32–50 hr., avg. 38. Avg. chem. dosages: alum 2.46 gpg., lime 0.70 gpg., Cl 0.37 ppm. Revenue $18,501.47; expenses $20,400.11. Cost per mil.gal. $95.08 or $6.17 per capita. Meter rates 35¢ per 1000 gal. (U.S.). No charge for fire protection. Underground storage 140,000 gal.; elevated 100,000.—*R. E. Thompson.*

**Annual Report, Kitchener, Ont., 1943.** W.W. Inf. Exch.—Can. Sec. A.W.W.A. **5**: E: 28: 50 (Feb. '44). Pop. 36,348. Supply from deep wells. Alky. 244, soap consuming power 445, chlorides 6 ppm. Avg. consumption 4.18 mgd. or 115 gal. per capita. Hydrant rental $35 per annum. Metered water rate 17.3¢ per 1000 gal. 6.5¢ for largest consumers. Plant value $809,271.03, debenture debt $4,465.06. Total revenue $109,336.79, disbursements $69,788.29. Surplus account now $308,521.66.—*R. E. Thompson.*

**Annual Report, Malarctic, Que., 1942.** ANON. W.W. Inf. Exch.—Can. Sec. A.W.W.A. **5**: E: 24: 42 (Dec. '43). Supply for pop. of 3200–3500 drawn from Malarctic R. above dam and treated by gravity mech. filtration and chlorination. 2 filters each have capac. of 250 gpm. Water pumped direct to system from 35,000-gal. clear water storage. Filters washed with water from 1300-gpm. pump. Consumption avgd. 0.227 mgd.—68 gal. per capita. Filter runs 25.5–382 hr. Alum dosage 3.0–10.27 gpg., avg. 5.41; soda ash 1.65–5.72, avg. 2.7, exclusive of that used for corrosion control.—*R. E. Thompson.*

**Ottawa Report, 1942.** ANON. W.W. Inf. Exch.—Can. Sec. A.W.W.A. **5**: E: 25: 44 (Dec. '43). Ottawa R. water treated by gravity mech. filtration and chlorination. Pop. served 179,160; 158,581 within city limits. Only 8% of 33,187 services metered. Consumption 19.716 mgd.—110 gal. per capita. Avg. chem. dosages: alum, 2.66 gpg.; lime, 0.81 gpg.; $Cl_2$, 3.36 lb. per mil.gal. In addn., 2990 lb. activated C used. Avg. filter run 73.28 hr.; wash water 1.77%. Avg. rate of filtration 65.57 mgd.—*R. E. Thompson.*

## ADMINISTRATION, PERSONNEL AND PUBLIC RELATIONS

**Training of the Young Water Engineer.** H. R. DAVENPORT. Surveyor (Br.) **103**: 87 (Feb. 25, '44). It is better for youth to take full-time course at university because of increasingly scientific basis of water eng. Thereafter, experience governed by type of work handed to him. Young engr. has to seek varied experience by going from job to job. Few students continue at university after completing 3-yr. degree course. Nowhere can he obtain instruction in specialized subject of water eng. Author ests. annual intake into water works profession to be only 14; can find room for only 420 qualified water engrs. in British Isles. Water engr.'s work may be divided into 4 main sections: (1) initiation, design and constr. of new works; (2) production of wholesome water and maint. of works; (3) distr. of finished product; (4) management and admin. and contacts with governmental depts. Water engr. requires thorough knowledge of civ. eng., involving constr., mech. and elec. eng., with organizing ability to carry out constr. by direct labor; knowledge of chemistry and bacteriology, legislation affecting water works, business and admin. methods of plumbing practice and considerable knowledge of hydraulics. Principal lack of training mostly in operation and management. No attempt at specialized training should be made until man has passed or become exempt from

examns. of Inst. of Civ. Engrs. Having arrived at stage where specialization is required he should be given definite jobs to undertake and one or two juniors should be placed under his supervision. Addnl. theoretical knowledge must be mainly from books. Formation of schools covering 3 days would enable young engrs. to hear lectures by specialists. Addnl. qualification for election to assoc. membership of Inst. of Water Engrs. should be of written paper.—*H. E. Babbitt.*

**Methods of Training the Young Engineer.** J. F. Bailey. Surveyor (Br.) **103:** 88 (Feb. 25, '44). Two accepted methods of entry into water works eng. profession at present: (1) articled pupil or assistant under agreement and (2) student direct from university. First method affords best opportunity for training of young engr. Best training that could be given is to spend fixed time at university with 2 yr. articled to practical work in admin. Whenever possible pupil should come under direct supervision of chief engr. As general practice, young engr. takes degree course or higher national course at evening classes, day classes usually being reserved for practical work in surveying and hydraulics. During pupilage student should devote as much time as possible to practical side of water works eng. Schedule of training which covers most branches of profession: *First yr.*—visits to various water works, drafting office routine, surveying, distr. systems and filing of eng. papers. *Second yr.*—drafting office routine; surveying; distr.; operation of filter units, chem. plants, pumps and chlorination; filing of records and prepn. of graphs. *Third yr.*—drafting office routine, surveying, distr., acting as clerk of works, and practical experience on all outside work. *Fourth yr.*—drafting office routine, surveying, distr., practical experience on outside work, writing specifications and bills of materials. *Fifth yr.*—paid junior eng. assistant. Would be far more satisfactory if Inst. held examn. covering subjects pertaining directly to water works such as: (1) water works law and administration; (2) constr. of reservoirs; (3) filtration, pumping and distr.; (4) chemistry and bacteriology; and (5) geology. Training of young engrs. who are at present with Armed Forces another point to consider. Opportune to refer to need for making prospects of intending engrs. attractive in all respects.—*H. E. Babbitt.*

**Training of Water Engineers.** Anon. Surveyor (Br.) **103:** 127 (Mar. 17, '44). N. A. F. Rowntree pointed out difficulty youth had in selecting future occupation. Suggested closer collaboration between technical institutions, education authorities, schools and pupils. Considered that full-time university training only satisfactory system. Wished that "refresher courses" could be provided at universities. S. G. Barrett preferred would-be water engr. to have liberal university education interspersed with manual eng. work during vacations. Apprentice system should be abolished. E. C. Oakes suggested danger in emphasis on academic aspect of training and put in plea for more practical training. A. Boothman agreed with Oakes and Rowntree. Smaller undertakings have peculiar and varied problems and pupil might receive better training therein than in larger undertaking where training might be sectionalized. H. Cannel stated it was apparently only smaller authorities which allowed engrs. to take articled pupils. At Liverpool Univ. students compelled to seek practical work during vacations. He visualized possibility of whole framework of water eng. changed after war. Need for qualified eng. staff would increase. Maybe central school for training of young engrs. on lines adopted by Post Office would be possible. D. Lloyd said trainee scheme might be divided as follows:

| *No of Months* | *Occupation* |
|---|---|
| 1 | Office—secretarial: Annual reports, etc., correspondence, daily reports and filing, committee work, requisitioning and ordering. |
| 1 | Catchment and impounding works: Gages, embankments, valves, etc., or underground supplies. |
| 2 | Aqueduct: Maint. and management, filtration and treatment of water. |
| 1 | Examination of water: Sampling and observation of bact. and chem. anals. |
| 2 | Distr.: Trunk main laying. |
| 2 | Distr.: Service reservoirs, district planning, small pipe laying and scraping. |
| 1 | Waste detection: Night testing, day follow-up. |
| 4 | Mech. workshop: Meter and other repairs, foundry work, machine |

work; testing materials; visiting wells and pumping stations.
5–6 Drawing office: Design, quants., specifications.
5–6 Constr. of new work.

J. R. Roberts said that senior engrs. should treat training of young engrs. as responsibility to future advancement of profession. R. Wyllie said there was one aspect which had not been mentioned, namely, suitability of candidate for training. Most successful type was young man who, having reached matriculation std., had gone into office for general duties and was then presented with chance of becoming assistant. P. A. Watford thought much to be said favoring pupilage system provided principal competent to undertake training combined with university attendance during whole period of articles. M. T. B. Whitson questioned Davenport's est. that intake of engrs. into profession only 14 per yr. If, as seems generally agreed, university training is proper course, final and directive training must be left to water engr.'s office. J. K. Swales impressed by small numbers, making it impractical for water supply courses to be provided at every university. This might be achieved by British W.W. Assn. subsidizing selected university. F. Margerison favored articled pupilage combined with 2 or 3 yr. at university.—*H. E. Babbitt.*

**A Training Program for Replacement Sanitarians in Michigan.** JOHN M. HEPLER. Mich. Pub. Health **31:** 208 (Nov. '43). Policy adopted to fill vacancies with suitable local men having these qualifications: at least have high school education, preferably college completed or in part; be classified as 4F or over 38 yr. old; have good reputation and pleasing personality; be able to meet people easily; if possible, previously engaged in business affording health and sanitation fundamentals. Appointment to be recognized strictly as emergency, provisional employment for duration, although employee to know proper interest and accomplishment could lead to formal training and permanent employment. This method of staff maint. has technical objections but merits in stressing local talent in local govt. functions. Recognized some orientation to maint. uniform procedures, continue established programs and indoctrination into principles and policies of public health organization needed. School of Public Health, Univ. of Mich., easily accessible and co-operative. Four-week study course planned. First week, as comprehensively as possible, devoted to subject of water, including potable public and private supplies, swimming and bathing water, cross-connections and back-siphonage. Second week given to sewage and excreta disposal—public and private, garbage disposal, rodent control, mosquito control, light, heat and ventilation. Third week to cover milk sanitation from producer to pasteurization plant, restaurant, school and resort sanitation and nuisances. During 3 weeks, 1-hr. lectures given on subjects re whole public health program and pointed to show relation between sanitarian's work and that of director and nurses. At each weekend state health dept. representatives conducted 4-hr. discussion period to tie theories and procedures covered during week into state practices and programs. Fourth week in field with experienced san. engrs. Program details charted.—*Ralph E. Noble.*

**Some Notes on Water Works Management.** ERNEST STACE. Wtr. & Wtr. Eng. (Br.) **45:** 47, 94 (Aug., Sept. '42) (*Abstracted,* Jour. A.W.W.A. **35:** 350 ('43).) *Discussion. Ibid.* **45:** 219 (Dec. '42). L. WESTON: In past, too little attention paid to training of secretaries and, of late years, more progressive concerns have tendency to appoint qualified accountants as secretaries, showing lack of able candidates within industry. While accountants and secretaries have much in common, vital difference in main subject of their studies. Author's organization chart not applicable to all water works. Water undertakings commercial and principle of charging "entrance fee" does not belong to commercial enterprise. Rental system of water rates now out of date because it does not lend itself to modern office machinery. Punched card system not used by a water co. to full extent. House-to-house inspection for waste detection not only acts as check on waste, but insures that consumers pay special charges for garden hoses, car washing, etc. Inadequacy of records of mains kept by some water companies surprising. Properly kept "main book" giving written description of main makes it simple to find valve cover or hydrant box. Value of monthly reports not realized by all companies. Monthly reports essential if proper control to be exercised. *Author's Reply:* Some academic qualifications

essential for all positions of executive responsibility, allied to foundation of character and loyalty.—*H. E. Babbitt.*

**Water Supply. Propaganda Secures More Economical Use in London.** ANON. Munic. J. & Local Govt. Admin. (Br.) **50:** 1515 (Dec. 11, '42). Metropolitan Water Bd.'s successful "Save Water" campaign, which began Apr. 11, made public water-saving conscious. By end of Oct., 98,036 taps rewashered. In addn., 4000 to 5000 washers dispensed for individual repair. During campaign, water consumption trend downward. Oct. '42 consumption 38 mgd. less than Oct. '38; 15 mgd. less than Oct. '41. Further economy possible by controlling automatic flushing cisterns in public lavatories, hotels, restaurants and bldgs. In many instances, flushing cisterns run when premises not used. Estd. that 12-hr. shutoff would save 640,000 gpd.—*Ralph E. Noble.*

**The Amalgamation of Water Undertakings.** DELWYN G. DAVIES. Surveyor (Br.) **102:** 487 (Nov. 26, '43). 858 water works in England and Wales and 124 in Scotland, not including small authorities supplying pops. under 10,000, of which more than 100 in England and Wales. Majority of water works confined to supply so small a pop. that they cannot support efficient admin. Authorities not in position to pay salaries that would secure highly qualified staff, hallmark of which now recognized as corp. membership in Inst. of Civ. Engrs., together with membership in Inst. of Water Engrs. Of 640 suppliers providing for pop. less than 30,000, so few as 53 of their engrs. members or assoc. members. Amalgamation of smaller units desirable so that they may gain improved service through employment of higher tech. skill.—*H. E. Babbitt.*

**Water Cost, Ontario 1941.** ANON. W.W. Inf. Exch.—Can. Sec. A.W.W.A. **5:** B: 1: 1 (Feb. '43). Total cost of water produced per 1000 gal. in 167 Ontario municipalities tabulated. Cost given includes maint. and operation, admin., debt charges, etc. As would be expected, cost varies widely—from max. of 144¢ to min. of 2.6¢. Data derived from annual rpt. of Dept. of Munic. Affairs.—*R. E. Thompson.*

**Meter Reading and Billing Proposals Modified by Commission.** ANON. Pub. Util. Fort. **31:** 587 (Apr. 29, '43). Meter reading and billing proposals by N.Y. companies disapproved because they allowed too much latitude and choice in plans and methods. Would permit scheduling of meter reading for any period up to 66 days. Where meters read at intervals other than 28 to 33 days, applicable monthly charges would be correspondingly adjusted. Bills prorated to nearest one tenth month when other than scheduled period. Interim bill to be rendered for reading periods longer than 28 to 33 days, this to be credited to bill rendered for full use of service shown by meter readings. Provisions would permit companies to continue present monthly reading plan or apply others. Failure to provide customer meter reading cards and bill accordingly, one objectionable feature. Prevention of increase to customers by reason of changes would be assured by meter reading cards. New provisions should be filed on statutory notice and be accompanied by affidavit of notification to OPA. Objections by labor unions expressed concern about plan creating unemployment. (Re *Consolidated Edison Co. of New York, et al.* (Case 10956).)—*H. J. Chapton.*

*Willing Water Says:*

**We Are Flushing Hydrants!**

The annual spring hydrant flushing is now in progress. For a short time you may draw some "rusty" water from your faucets. Such water is not "pretty", but don't be afraid of it—it contains nothing harmful.

We regret that this flushing is necessary twice a year to clear the mains of the rust that accumulates. If we did not do this you would be inconvenienced by rusty water frequently. We know! We tried it once!

After the job is finished, City water will be restored to its usual sparkle and clearness. There will be no flushing on Mondays—the usual family wash day.

*We ask your co-operation.*

**CITY LIGHT AND WATER UTILITIES**

**City Hall—Phone 7111**

*Earl E. Norman, Manager, City Light and Water Utilities, Kalamazoo, Mich., used this newspaper advertisement to tell customers about hydrant flushing.*